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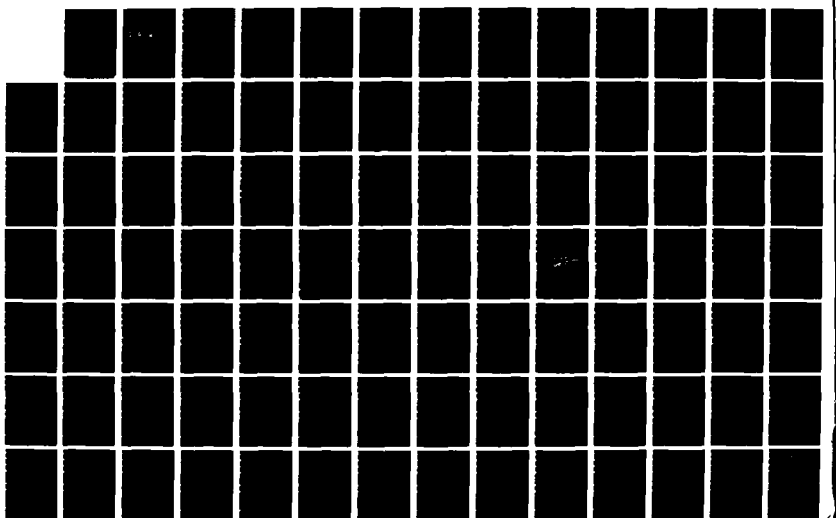

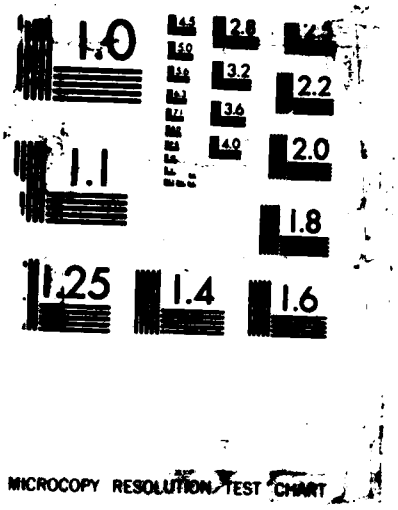
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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

MANAGING BACKLOG OF MAINTENANCE AND
REPAIR (BMAR)
IN THE MARINE CORPS

by

Lynn A. Price

December 1987

Thesis Advisor James M. Fremgen

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Managing Backlog of Maintenance and Repair (BMAR)
in the Marine Corps

by

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Captain, United States Marine Corps
B.S., East Tennessee State University, 1977

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

This thesis assesses the ability of the Marine Corps to effectively manage backlog of maintenance and repair (BMAR) and predict future maintenance and repair requirements. The current Marine Corps real property maintenance program is evaluated along with the BMAR model used by Headquarters, Marine Corps. In addition, the methods and models used by the Department of the Navy, Department of the Air Force, and Department of the Army for predicting maintenance and repair requirements are examined. The thesis includes the results of a field questionnaire which focuses on the actual operations at Marine Corps activities. It also identifies the factors which cause BMAR to increase and alternatives to using BMAR as an indicator of real property condition.

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I. INTRODUCTION

A. GENERAL DESCRIPTION OF THE ISSUE

Congress has been concerned for many years about the level of real property maintenance and repair performed on Department of Defense (DOD) real property holdings. The House Appropriations Committee expressed concern that funds being approved by Congress for maintenance and repair of real property were being diverted to operational requirements, resulting in possible further deterioration of property. To correct this situation, Congress established a statutory floor in the operation and maintenance appropriation for maintaining real property in the fiscal year 1963 DOD Appropriation Act. A statutory floor has been included in every subsequent appropriation act. [Ref. 1: p. 5]

During fiscal years 1973 through 1978, DOD's actual expenditures for maintenance of real property (MRP) exceeded the statutory floor established by Congress by an average of $371 million a year. Despite additional funds being used for MRP, DOD's backlog of maintenance and repair (BMAR) increased from $669 million at the end of fiscal year 1972 to $2,183 million at the end of fiscal year 1978. [Ref. 1: p. 12] The increase in BMAR resulted in the House proposing a containment level.

The conference report on the fiscal year 1979 Defense Appropriations Act adopted the House's proposal for containing the BMAR to the end of the fiscal year 1978 level [Ref. 2: p. 16]. The Congressional BMAR goal was established to prevent further deterioration of bases, force the services to maintain facilities, and focus attention on BMAR as a key indicator of the adequacy of annual maintenance and repair funding. For the Marine Corps, the BMAR containment level was set at $105.9 million [Ref. 1: p. 12]. Although Congress has provided additional operations and maintenance funds deliberately to reduce BMAR, it continues to increase. The projected fiscal 1989 BMAR for the Marine Corps is $361.5 million [Ref. 3].

Certainly, the Marine Corps' BMAR containment goal cannot be met by fiscal year 1990 within the current budget projections. In this era of austere funding, the Marine Corps needs to become more effective in predicting MRP requirements for future years and more efficient in resource allocation.

B. OBJECTIVE AND PRIMARY RESEARCH QUESTIONS

1. Objective

The objective of this thesis is to assess the ability of the Marine Corps to effectively manage BMAR and predict future maintenance and repair requirements for use in the Planning, Programming, and Budgeting System (PPBS).

2. Primary Research Questions

The primary research questions are as follows:

- What is the definition of BMAR?
- What factors cause BMAR to increase?
- Are there any alternatives to using BMAR as an indicator of MRP requirements?
- How reliable is the reported BMAR?
- What models are available for predicting future maintenance and repair requirements?

C. SCOPE

This thesis will evaluate the current method of determining BMAR in the Marine Corps, starting with the control inspection program requirements. The review will include the activities' responsibility for developing the Long Range Maintenance Plan (LRMP), Annual Work Plan, and the BMAR Report and Projects Plan. The process of reviewing and consolidating individual activities' requirements to determine Marine Corps-wide requirements at Headquarters, Marine Corps will be reviewed. Of special interest is the current model used by the Real Property Maintenance Activities (Code LFF) Section in predicting future maintenance and repair requirements for inclusion in the budgeting cycle. In addition, the methods and models used by the Department of the Navy, Department of the Air Force, and Department of the Army for predicting maintenance and repair requirements will be reviewed.

D. RESEARCH METHODOLOGY

This thesis is primarily inductive in nature and uses two basic research strategies: opinion and archival. A large portion of the thesis is based on opinion research through the use of questionnaires and individual interviews. Questionnaires were distributed to each of the Marine Corps shore activities' Facilities Management Officers at a meeting held at Headquarters, Marine Corps on 20 August 1987. A copy of the questionnaire is included in Appendix B.

In addition, individual interviews were conducted with personnel within the Real Property Maintenance Activities Section at Headquarters, Marine Corps, and equivalent key personnel at the Headquarters level of the Navy, Air Force, and Army. Appendix C contains a list of interview questions.

Secondary archival research was used to obtain historical data on MRP budget requirements, BMAR, and inventory value. Directives, orders, General Accounting Office reports, congressional reports, and congressional hearings provided additional data concerning MRP and BMAR.

E. SUMMARY OF FINDINGS

The conclusions state the Marine Corps MRP program is well designed and should result in effective management when complied with. The validation process for BMAR deficiencies is the most comprehensive of all the services. The reliability and accuracy of reported Marine Corps BMAR improves every year due to increased emphasis on identifying deficiencies, better inspection procedures, improved reporting procedures, and refinements to the BMAR model. Despite the increase in reliability of BMAR, it is not a true indicator of the condition of real property; and other alternatives to using BMAR should be explored. Further, for the Marine Corps to reach its BMAR containment goal, significant changes in the MRP program will have to be made.

F. ORGANIZATION OF THE THESIS

The remainder of the thesis is organized as follows: Chapter II provides a history of BMAR and includes historical data on the the Marine Corps MRP budget requirements, BMAR, and inventory. Chapter III identifies the current real property maintenance program in the Marine Corps. It includes the scope, maintenance standards, workload development, records, and reports. A summary of the interviews conducted with the Navy, Air Force, and Army on BMAR managements is described in Chapter IV. Chapter V is a comparison of the methods used by each of the services. Chapter VI contains a summary of the Marine Corps field questionnaire results. Conclusions and recommendations are presented in Chapter VII.

II. BACKGROUND

A. REAL PROPERTY MAINTENANCE ACTIVITIES

The term real property maintenance activities is used to describe four functional categories of work. These functional categories are identified as follows: [Ref. 4: p. 2-1]

- Various functions for the maintenance and repair of facilities
- Accomplishment of minor construction
- Operation or purchase of utilities
- Provision of operating services and other engineering support

The maintenance of real property (MRP) program consists of two of the above four functional categories--maintenance and repair of facilities and minor construction. Maintenance and repair of facilities and minor construction are defined as follows: [Ref. 5: pp. 5,6]

> Maintenance is the work required to preserve and maintain a real property facility in such condition that it may effectively be used for its designated functional purpose. Maintenance includes work done to prevent damage which would be more costly to restore than to prevent.
>
> Repair is the restoration of a real property facility to such condition that it may effectively be used for its designated purpose. Repair may be overhaul, reprocessing, or replacement of deteriorated component parts or materials.
>
> Minor construction is work to erect, install, or assemble a new facility or to expand, alter, or convert an existing facility to another use.

Only minor construction projects up to certain amounts (to be detailed in Chapter III) can be financed with funds from the operation and maintenance appropriation. MRP work may be performed by an in-house force, by personnel under a self-help program, by military units as a training project, or by contract. [Ref. 5: p. 7]

1. Other Aspects of MRP

Two important aspects of the MRP program are the statutory floor imposed by Congress and BMAR.

a. Statutory Floor

Congressional concern for continued deterioration of real property and growth in maintenance and repair lead to the establishment of a minimum obligation, called a floor, for MRP expenditures beginning with the fiscal year 1963 DOD Appropriation Act. The statutory floor provision for MRP has been identified in every subsequent appropriation act since 1963 and applies to the operation and maintenance appropriation only. [Ref. 1: p. 5]

In 1962, each military service reported the dollar amounts of expected expenditures for MRP to Congress. Thus, Congress established the floor amount for each service at the identified expected expenditure level. Congress continued this method of assigning floors through fiscal year 1971. DOD issued general guidance to the services for identifying, measuring, and compiling dollar amounts to meet the floor based on the 1963 DOD Appropriation Act and accompanying reports. [Ref. 1: pp. 5,6]

Beginning in fiscal year 1972, the Army and Air Force proposed floors lower than their estimated expenditures. Congress agreed to the lower floor amounts. By fiscal year 1975, all the services were requesting floors lower than the estimated expenditure level. The House Committee on Appropriations expressed concern over the lower floors, which, in effect, allowed the services to reprogram funds from MRP to other operations and still meet the statutory floor requirement. For fiscal year 1975, Congress established the floor slightly below the amounts requested for maintenance. [Ref. 1: p. 6] The statutory floor is currently established at not less than 90 percent of the amount proposed by the appropriation committees for MRP [Ref. 5: p. 8].

b. BMAR

In general, any maintenance and repair work for real property remaining at the end of the fiscal year on the installation's annual work plan, which work cannot be accomplished, is reported as BMAR for the installation. The BMAR is normally submitted through command channels to support the annual service budget submission. [Ref. 6: p. 93] BMAR does not include regularly scheduled maintenance and repair work identified for accomplishment during the fiscal year at the installation. The concept of BMAR applies to all sources of MRP funding, although BMAR is generally thought to apply only to the operation and maintenance appropriation. [Ref. 5: p. 8] For the purposes of this thesis, BMAR will refer only to the operation and maintenance appropriation, unless otherwise stated.

B. EVOLUTION OF THE BMAR CONCEPT

DOD Instruction 4150.9 dated March 1, 1960 required each service to report the backlog of essential maintenance deferred at the end of the fiscal year to DOD. The instruction further defined essential maintenance as follows [Ref. 1: p. 7]:

> 1. The routine recurring work required to keep a facility (plant, building, structure, ground facilities, utilities systems, or any real property) in such a condition that it may be continuously utilized at its original designed capacity and efficiency, for its intended purpose.
>
> 2. The restoration of a facility to a condition substantially equivalent to its original or designed capacity and efficiency by replacement, overhauling, or reprocessing of constituent parts or materials.

These definitions were very similar to the general definitions stated for maintenance and repair at that time. The key factors for reporting were that the work was deferred at the end of the fiscal year and that the work was essential. [Ref. 1: p. 7]

In June 1963, the DOD instruction was revised and the new definition for backlog of essential maintenance and repair became [Ref. 1: p. 7]:

> . . . those items of maintenance and repair as defined in DOD Dir. 7040.2 over $10,000 which cannot be accomplished during the current fiscal year due to lack of resources. An item is considered essential when delay for inclusion in a future program will impair the military readiness and capability, or will cause significant deterioration of real property facilities.

Note that the revised definition included two new concepts. First is the $10,000 threshold, which precluded items easily funded at the installation level. Second, "essential" was defined in terms of military readiness and capability or facility deterioration. [Ref. 1: p. 8]

In 1962, a DOD Real Property Maintenance Council was established. The purpose of the council was to provide a forum to exchange ideas and information for improving real property maintenance management. Between 1964 and 1969, the council made the following recommendations: [Ref. 1: pp. 8,9]

- Reemphasize importance of backlog system.
- Do not consider backlog the prime indicator of maintenance requirements.
- Revise backlog definition to include the summation of all maintenance and repair requirements known to exist at the time of reporting.
- Develop a program control system which indentifies total maintenance requirements, provides a five year defense plan, and provides fiscal guidance.

In response to the recommendations, DOD implemented a program control system in August 1973 by DOD Instruction 4165.58. The instruction redefined backlog to delete the $10,000 limitation and delete the word "essential". In addition, the new definition reflected all unfinanced maintenance and repair backlog. [Ref. 1: p. 9] Since 1973, the DOD instruction has been revised several times. The current DOD instruction [Ref. 4] canceled the program control system, deleted the uniform definition of backlog, and provided only general guidance to the services.

C. GROWTH IN BMAR

1. 1972-1978

In 1965, the DOD reported BMAR was $285 million. By 1972, the DOD BMAR had increased to $669.3 million. [Ref. 1: p. 41] Between 1972 and 1978, the services' BMAR increased an additional $1,513.7 million. See Table 1 for the breakdown of BMAR by service [Ref. 1: p.15].

TABLE 1

BACKLOG OF MAINTENANCE AND REPAIR ($MILLIONS)

	1972 (Note a)	1978	Increase	Percent Increase
Army	$222.6	$1,241.2	$1,018.6	557.6
Navy	345.0	536.0	191.0	155.4
Marine Corps	19.7	105.9	86.2	537.6
Air Force	82.0	299.9	217.9	365.7
Totals	$669.3	$2,183.0	$1,513.7	326.2

Note a: Prior to fiscal year 1973, the definition of the term backlog excluded those maintenance and repair deficiencies under $10,000.

The Army reported that $708 million of its $1,018 million increase occurred at overseas installations in Europe. The Army stated that the increased emphasis on identifying and validating reportable backlog during 1975 resulted in a significant increase in BMAR during the period July 1975 through September 1976. [Ref. 1: p. 17]

In 1977, the Navy changed its definition of what to report as backlog. This change had a significant impact on its reported backlog for 1977 and 1978. Had the definition not been changed, the reported backlog for 1978 would have been about $896 million instead of $536 million, or an increase of $551 million instead of $191

million. [Ref. 1: p. 17] Refer to Figure 2.1 for a graphic comparison of each service backlogs for fiscal years 1972-1978 [Ref. 1: p. 41].

During the period 1972 through 1978, total expenditures by service for maintenance and repair of real property exceeded both the statutory floor and planned expenditures, except for two instances. In 1975, the Navy's actual expenditures were $1.9 million less than planned. In 1976, the Army's actual expenditures were $33.3 million less than planned. Despite increases in actual expenditures for maintenance and repair, backlog continued to grow.

The following reasons for growth in BMAR were provided by the services [Ref. 1: p. 18]:

- Increased emphasis on identifying BMAR projects
- Priority of competing programs and overall fiscal constraints
- Inflation
- Further deterioration of previously identified deficiencies
- Change in BMAR definition in 1973 which eliminated the $10,000 limitation

2. **Containment Policy**

The fiscal year 1979 DOD budget request for real property maintenance funds identified a total backlog of $2,054.3 million for 1979. This was an increase of $49.8 million over the 1978 BMAR. The $2,054.3 million BMAR represented more than one year's maintenance effort and the House Committee on Appropriations wanted to reduce the BMAR to about six months of maintenance effort. Thus, the Committee recommended a containment policy for BMAR. [Ref. 6: pp. 93,94]

The containment policy held the backlog to an amount no greater than the end of the fiscal year 1978 amount. The Committee expected DOD to review the fiscal year 1979 BMAR situation and submit reprogramming actions, as needed, to reduce BMAR to the 1978 level. The Committee believed that when DOD implemented the policy of holding the backlog constant, despite inflation, additional incentive would be placed on identifying and accounting for BMAR, since any increase would require financing from within DOD. [Ref. 6: p. 94]

The Senate Committee on Appropriations concurred with the House's containment policy. The Conference report adopted the House position with respect to containing BMAR. DOD was to calculate and report the amount of BMAR as of September 30, 1978 to the Appropriations Committee for the purpose of establishing a baseline to institute the containment policy. [Ref. 2: p. 16] The reported BMAR for

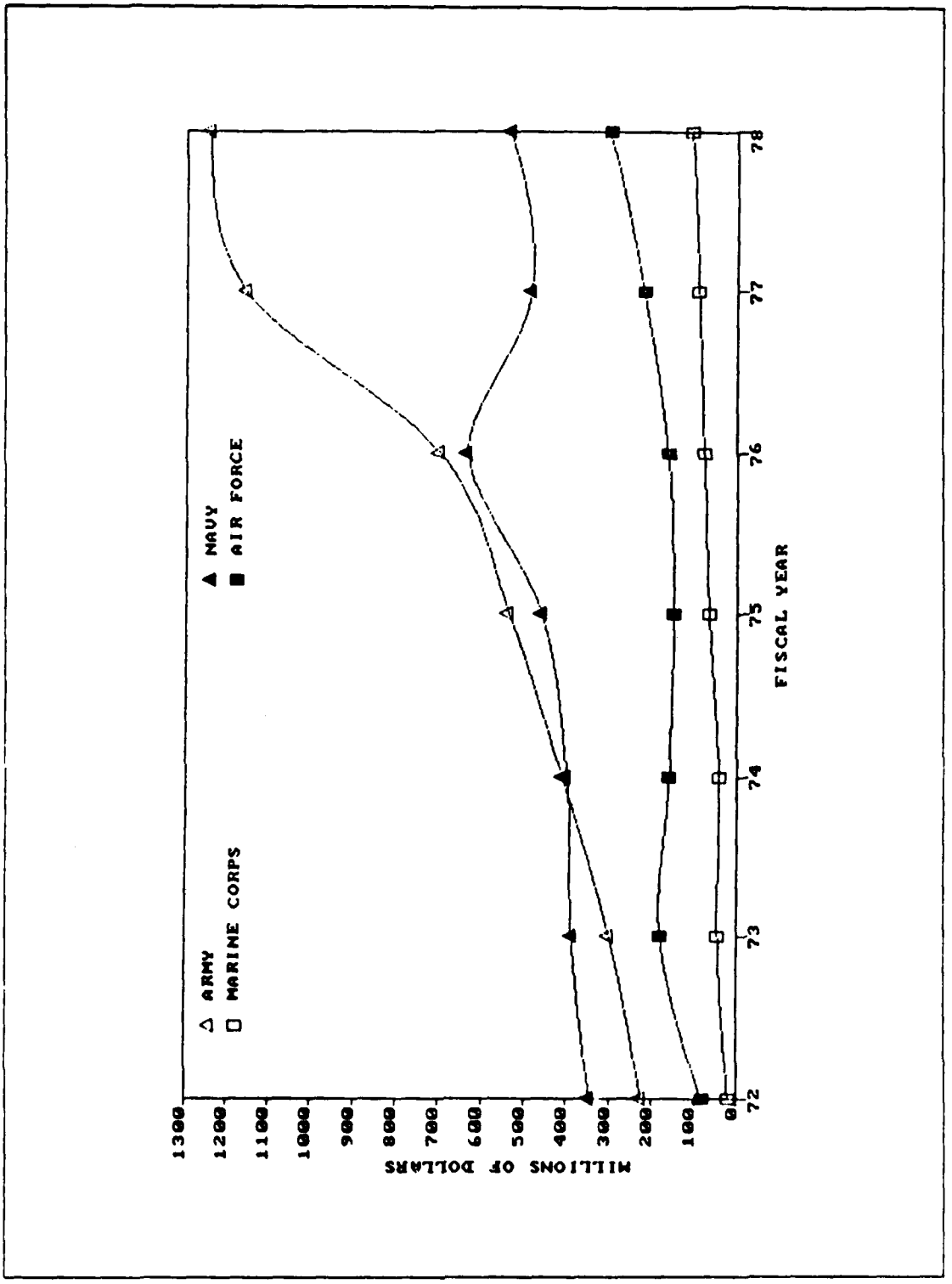

Figure 2.1 Graphic Comparison of Backlogs, Fiscal Years 1972-1978.

the end of fiscal year 1978, used as the baseline for the containment policy, is shown in Table 2 [Ref. 7: p. 138].

TABLE 2
END OF FISCAL YEAR 1978 BMAR ($MILLION)

	1978
Army	$1,241.2
Navy	536.0
Marine Corps	105.9
Air Force	299.9
Total	$2,183.0

3. **1979-1985**

DOD failed to contain the services' backlog to $2,183 million in the fiscal year 1980 through 1986 budgets. BMAR for 1979 was $2,246.5 million. It rose to $3,095.7 million for 1980 and to $3,676.1 million for 1981. [Ref. 8: p. 36] BMAR continued to grow through fiscal year 1981 largely because actual inflation was greater than budgeted. The funds provided for maintenance and repair, after adjustment for inflation, were insufficient to accomplish all the work required and BMAR continued to increase, but at a diminishing rate. However, the BMAR increases were not due to decreases in maintenance funding. MRP funding increased from $1,906 million in 1978 to $2,553 million in 1981. [Ref. 7: p. 137]

In 1979, Mr. Perry Fliakas, Deputy Assistant Secretary of Defense (Installation and Housing), stated that DOD strongly emphasized the containment and or long range reduction of BMAR. However, the MRP program competed with vital mission programs; and readiness programs took priority over MRP. Also, the services' aggressive actions of identifying, validating, and recosting deficiencies increased the backlogs. [Ref. 9: p. 65] General DOD guidance to the services was as follows [Ref. 9: p. 62]:

(1) Reduce backlog to a manageable level as the first objective.

(2) If manageable level cannot be reached within a five year period, accomplish within an eight year period.

(3) If above two cannot be accomplished, do not let BMAR grow, contain it.

Over the five year period 1981-1985, DOD doubled the number of dollars expended on repair and maintenance. [Ref. 10: p. 700] Meanwhile, BMAR peaked in fiscal year 1981 at $3.7 billion and decreased to $3.1 billion by the end of 1985--a decrease of $.6 billion. Refer to Figure 2.2 for a graphic comparison of each service backlogs for fiscal years 1979-1985.

D. GENERAL ACCOUNTING OFFICE FINDINGS

In 1978, Congress requested the General Accounting Office (GAO) to review DOD's real property BMAR projects. The scope of the review included historical development and trends in BMAR, management policies, uniformity in application of policies and standards, and reliability of estimates. The review was completed in two phases over a two to three year period. [Ref. 1: cover letter]

The review concluded that Congress cannot rely on the military services' reported real property BMAR for the following reasons [Ref. 11: p.32]:

(1) Lack of uniform BMAR definition and reporting requirements between services.

(2) Services arbitrarily constrain the level of reported BMAR.

(3) Inadequate facility inspection to identify deficiencies.

(4) Work plan not always used for reporting and managing BMAR.

(5) Insufficient review and validation of BMAR.

(6) Inadequate definition of manageable level of BMAR.

(7) Lack of guidance at installation levels on the use of BMAR in management of funds.

The report further states that Congress is not receiving a true picture of DOD's BMAR and the BMAR figures are grossly understated. Inconsistencies in the services for identifying and reporting BMAR has resulted in constrained BMAR figures. [Ref. 11: p. 4]

E. SURVEYS AND INVESTIGATIONS STAFF FINDINGS

In 1983, the House Committee on Appropriations requested the House Surveys and Investigations Staff investigate the MRP program. The scope of the investigation included all aspects of the MRP program, such as organization, decision making process, MRP floor, funding and execution, and BMAR. Findings in the area of BMAR are summarized as follows [Ref. 5: pp. 49-57]:

(1) Lack of uniform BMAR definition and management.

(2) BMAR containment policy cannot be considered a viable management tool.

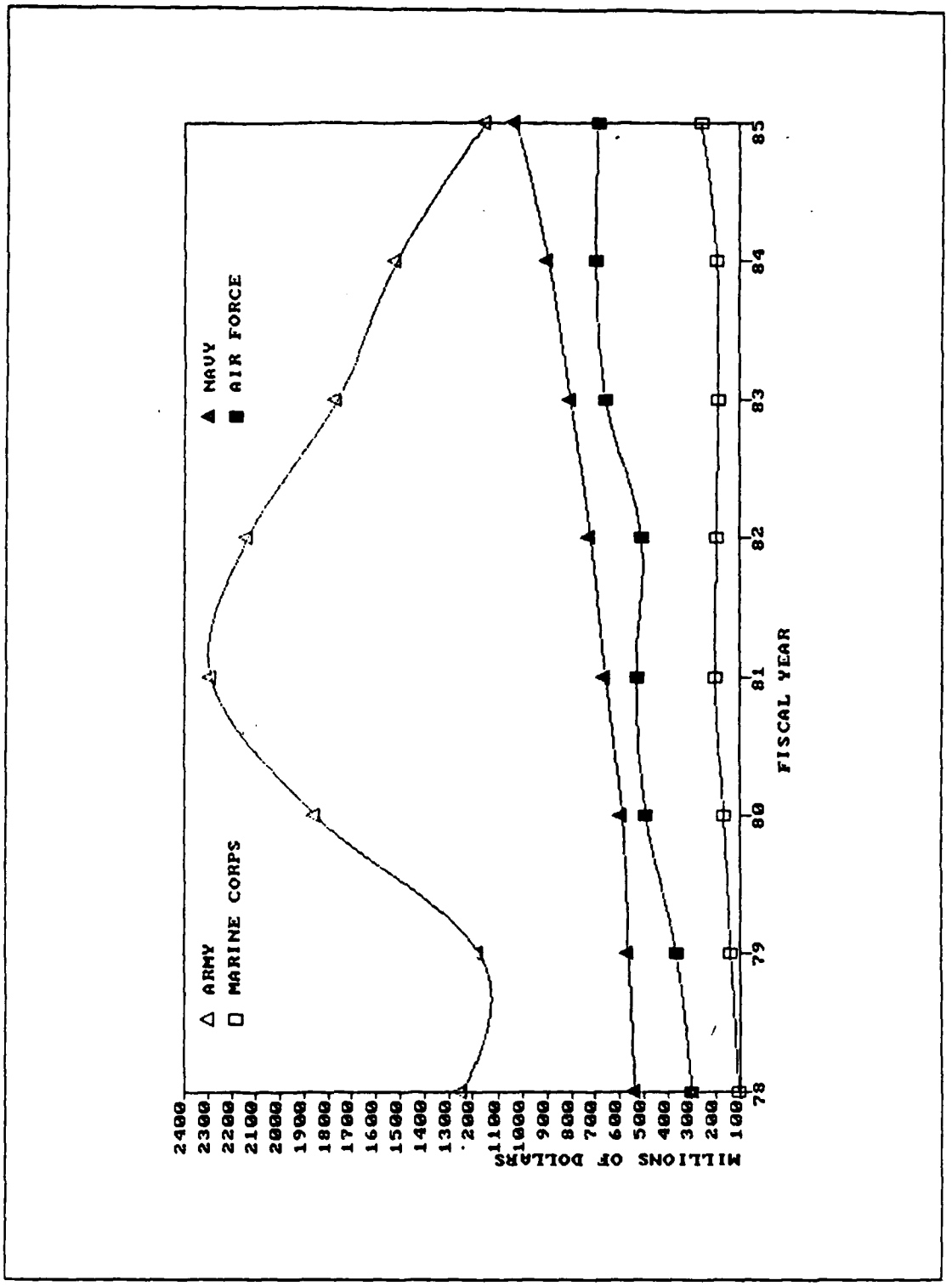

Figure 2.2 Graphic Comparison of Backlogs, Fiscal Years 1979-1985.

(3) Operation and Maintenance Appropriation BMAR is only about 58 percent of the total BMAR problem.

(4) BMAR is a poor indicator for determining the condition of real property.

(5) Alternatives to BMAR should be explored.

In response to the Surveys and Investigative Staff report, Mr. Robert Stone, Deputy Assistant Secretary of Defense (Installations) made the following comments on BMAR [Ref. 10: pp. 718-719, 732-735]:

(1) DOD does not ever expect to work the BMAR down to the containment level; however, BMAR has been reduced from a workload of fourteen months to ten months. There is no BMAR figure that would be a reasonable target.

(2) The projects identified in BMAR are valid projects, but BMAR does not contain all the projects that have to be completed.

(3) BMAR is not an indicator of maintenance and repair need and should not be used to justify MRP funding.

(4) DOD has no uniform definition for BMAR.

(5) BMAR is not considered a good management indicator for base allocation of resources.

(6) One alternative approach to using BMAR, is to take a percentage of the replacement value of real property and use that as the annual MRP funding requirement. This method should only be used as a rule of thumb, because more than the use of a standard across similar facilities enters into the process. Each service and installation has different priorities and each installation should be able to exercise its own priorities in carrying out its mission.

F. MARINE CORPS HISTORICAL DATA

1. Current Plant Value (CPV)

One of the reasons for increasing MRP requirements is the increasing inventory of facilities. Inventories increase as a result of military construction (MILCON) projects, minor construction projects, Japanese facilities improvement program (JFIP) projects, and nonappropriated fund projects. The Commander, Naval Facilities Engineering Command is responsible for maintaining a central inventory for class 1 and 2 property [Ref. 12: p. 6-3]. By definition, class 1 plant property is land. Class 2 plant property consists of buildings, structures, and utilities [Ref. 12: p. 6-5].

The Navy Facility Assets Data Base (NFADB) System provides an automated file of data on each existing facility in the Marine Corps. The NFADB includes data on the facility, location, acquisition, construction, measurements, cost, capacity, utilization, and condition [Ref. 12: p. 6-25]. Marine Corps activities are required to

report all changes in acquisition, disposals, and capital improvements to the Facilities Systems Office at Port Hueneme, California. Changes are inputed into the NFADB and new plant property records are distributed to the applicable activity for reconciliation against accounting records. [Ref. 12: pp. 6-34, 6-35] Within a three year cycle, all real property at each activity is physically checked against the inventory records and all entries are validated [Ref. 12: pp. 6-36, 6-37].

Since, 1978, the current plant value of class 2 real property Marine Corps-wide has steadily increased, except for 1986. In 1986, CPV decreased by $316 million. Refer to Table 3 for breakdown by year. The values in this table represent original costs, including subsequent modifications, inflated to current value by means of a construction price index.

TABLE 3

CURRENT PLANT VALUE OF CLASS 2 MARINE CORPS REAL PROPERTY ($MILLION)

Year	CPV
1978	$7,065
1979	8,084
1980	8,787
1981	9,589
1982	9,961
1983	10,452
1984	10,975
1985	11,342
1986	11,026

2. MRP Funding

In addition to increasing inventories, MRP requirements increase due to complexity, age, inflation, and human and technological factors. Examples of increased complexity are these: New bachelor enlisted quarters are built motel-style instead of open squadbays; training facilities have more electronics and mechanical equipment; and even messhalls have more sophisticated equipment. The average age of Marine Corps facilities is 33.5 years. Sixty-eight percent of the inventory is 30 or more years old. Using fiscal year 1978 as the base year, $1.00 in 1978 has inflated to $1.73 in fiscal year 1987. Human and technological factors include such things as better qualified personnel, improved inspections, use of higher standards, and increased emphasis on identifying MRP requirements. [Ref. 13: pp. 43-49]

During the period 1978 through 1986, actual MRP funding continued to increase until 1984 when it peaked and started decreasing. MRP budget requests also peaked in 1984 but reached a higher peak in 1987 (refer to Table 4).

TABLE 4

MRP BUDGET VS ACTUAL MRP ($MILLION)

Year	MRP Budget Request (a)	MRP Actual (b)
1978	$ 89	$ 98
1979	114	123
1980	106	131
1981	166	163
1982	191	209
1983	226	222
1984	263	246
1985	252	226
1986	242	218
1987	347	---

Note a: Figures as identified in applicable President's Budget Submissions for the Operation Appropriation Department of Navy, Supporting Data.

Note b: Figures as identified in Marine Corps answers to DOD questions, dated May 6, 1986.

TABLE 5

MARINE CORPS BMAR, 1978-1986 ($MILLION)

Year	BMAR
1978	$106
1979	139
1980	167
1981	203
1982	194
1983	190
1984	193
1985	258
1986	305

3. BMAR

The trend of Marine Corps BMAR for 1972 through 1978 is shown in Figure 2.1. During these years BMAR increased from $19.7 million in 1972 to $105.9 million in 1978. In 1978, the Marine Corps' BMAR was grossly underestimated due to the lack of command interest. However, increased emphasis and training at the field commands in identifying BMAR and improvements in the Marine Corps' ability to predict future BMAR have greatly improved the validity of BMAR in recent years. Despite the additional funds provided by Congress to reduce BMAR, it continued to grow through 1981. During 1982 and 1983, BMAR was reduced. In 1984, BMAR started to rise again. Table 5 identifies the Marine Corps' BMAR for 1978 through 1986 [Ref. 14: p. 5]. Figure 2.3 provides a comparison of the actual Marine Corps maintenance and repair funding to BMAR levels for fiscal years 1978 through 1986.

Historically, Congress has encouraged DOD to expend more on MRP and to contain BMAR. Under the containment policy established during the fiscal year 1979 defense appropriation, BMAR was to be reduced by not allowing the total backlog to exceed the fiscal year 1978 level of $2.1 billion. Nevertheless, BMAR has continued to grow and remains more than $1 billion above the containment level. As shown in Figure 2.2, BMAR reduction efforts by the services have not been uniform. Since 1978, the Army has been the only service to make progress toward BMAR reduction.

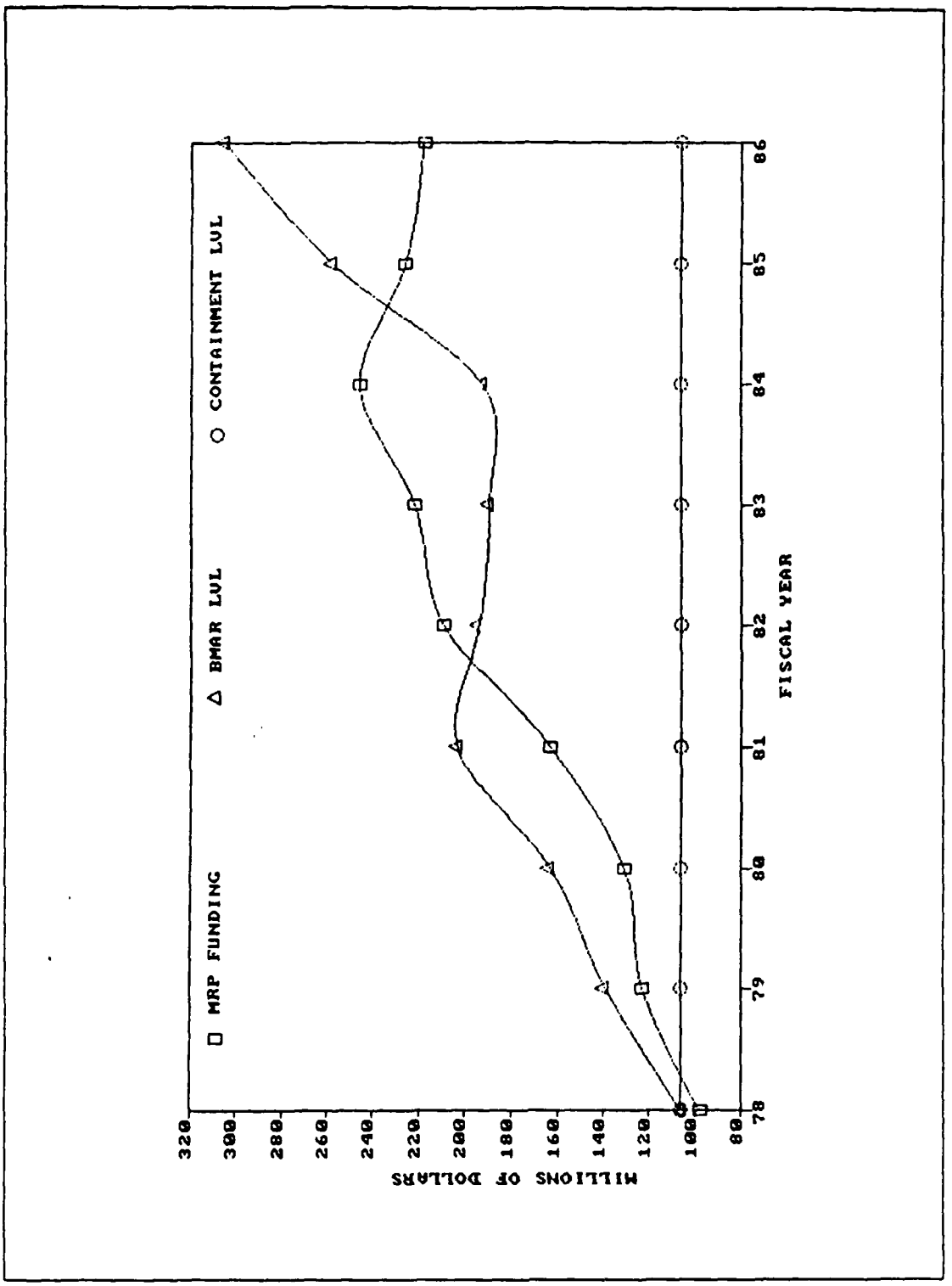

Figure 2.3 Marine Corps MRP Funding vs BMAR Levels, 1978-1986.

III. REAL PROPERTY MANAGEMENT WITHIN THE MARINE CORPS

A. APPLICABLE SHORE ACTIVITIES

The Marine Corps has nineteen major shore activities and four minor shore activities responsible for the implementation and management of a Real Property Maintenance Activities (RPMA) program. Activities are classified as major or minor primarily on the basis of overall physical size. [Ref. 15: p. 1-4] The specific shore activities are identified below [Ref. 16: pp. A-9, A-10].

Major Activities:

(1) Marine Corps Air Station, Cherry Point, North Carolina
(2) Marine Corps Air Station, Beaufort, South Carolina
(3) Marine Corps Air Station, New River, North Carolina
(4) Marine Corps Air Station, El Toro, California
(5) Marine Corps Air Station, Yuma, Arizona
(6) Marine Corps Air Station, Tustin, California
(7) Marine Corps Base, Camp Lejeune, North Carolina
(8) Marine Corps Base, Camp Pendleton, California
(9) Marine Corps Air-Ground Combat Center, Twentynine Palms, California
(10) Marine Corps Air Station, Futenma,Okinawa
(11) Marine Corps Air Station, Kaneohe Bay, Hawaii
(12) Marine Corps Air Station, Iwakuni, Japan
(13) Camp Smedley D. Butler, Okinawa
(14) Camp H. M. Smith, Hawaii
(15) Marine Corps Development and Education Command, Quantico, Virginia
(16) Marine Corps Recruit Depot, Parris Island, South Carolina
(17) Marine Corps Recruit Depot, San Deigo, California
(18) Marine Corps Logistics Base, Barstow, California
(19) Marine Corps Logistics Base, Albany, Georgia

Minor Activities:

(1) Camp Elmore, Norfolk, Virginia
(2) Headquarters Battalion, Henderson Hall, Washington, D. C.
(3) Marine Barracks, 8th and I Streets, Washington, D. C.
(4) First Marine Corps District, Garden City, Long Island, New York

The Marine Corps has over 11,000 buildings and 56 million square yards of pavement to maintain. These assets are spread over 1.6 million acres of land. By fiscal year 1988, the current plant value of class 2 property is estimated to be $11.3 billion. [Ref. 13: p. 4]

B. WORK SCOPE AND MAINTENANCE STANDARDS

RPMA includes the following four functional areas [Ref. 16: p. 3-3]:

(1) Operations of utilities
(2) Other engineering support services
(3) Minor construction
(4) Maintenance and repair of real property

Figure 3.1 shows the breakdown of the Marine Corps fiscal year 1987 RPMA program by functional area [Ref. 13: p. 8].

Work may be performed in-house, by contract, by military as a training project, or by military self-help. Services may be reimbursable or nonreimbursable. RPMA services are reimbursable to the host activity from the following sources: [Ref. 15: p. 1-4]

(1) Non-appropriated Fund Activities
(2) Family Housing Navy and Marine Corps
(3) Industrial Funds
(4) Department of Defense Holding (Disposal) Activities
(5) Research, Development, Test and Evaluation Funds

The costs of RPMA include labor, material, hourly use of equipment, and contracted services. Separate functional category codes (FCC) are used to collect appropriation and cost data for each of the four functional areas. FCC N is used for engineering support services such as janitorial services, entomology, fire protection, refuse collection, environmental control, and studies. FCC R is used for minor construction, improvements, and alterations. FCC M is used for maintenance and repair of all buildings, grounds, paved surfaces, utilities systems, and other real property facilities. [Ref. 16: p. 3-3]

Minor construction and repair projects are further divided into subfunctional category projects of R1, R2, M1, and M2. R1 are minor construction projects which can be accomplished within the local approval authority of the activity's Commanding Officer. R2 are minor construction projects which require approval from CMC and all

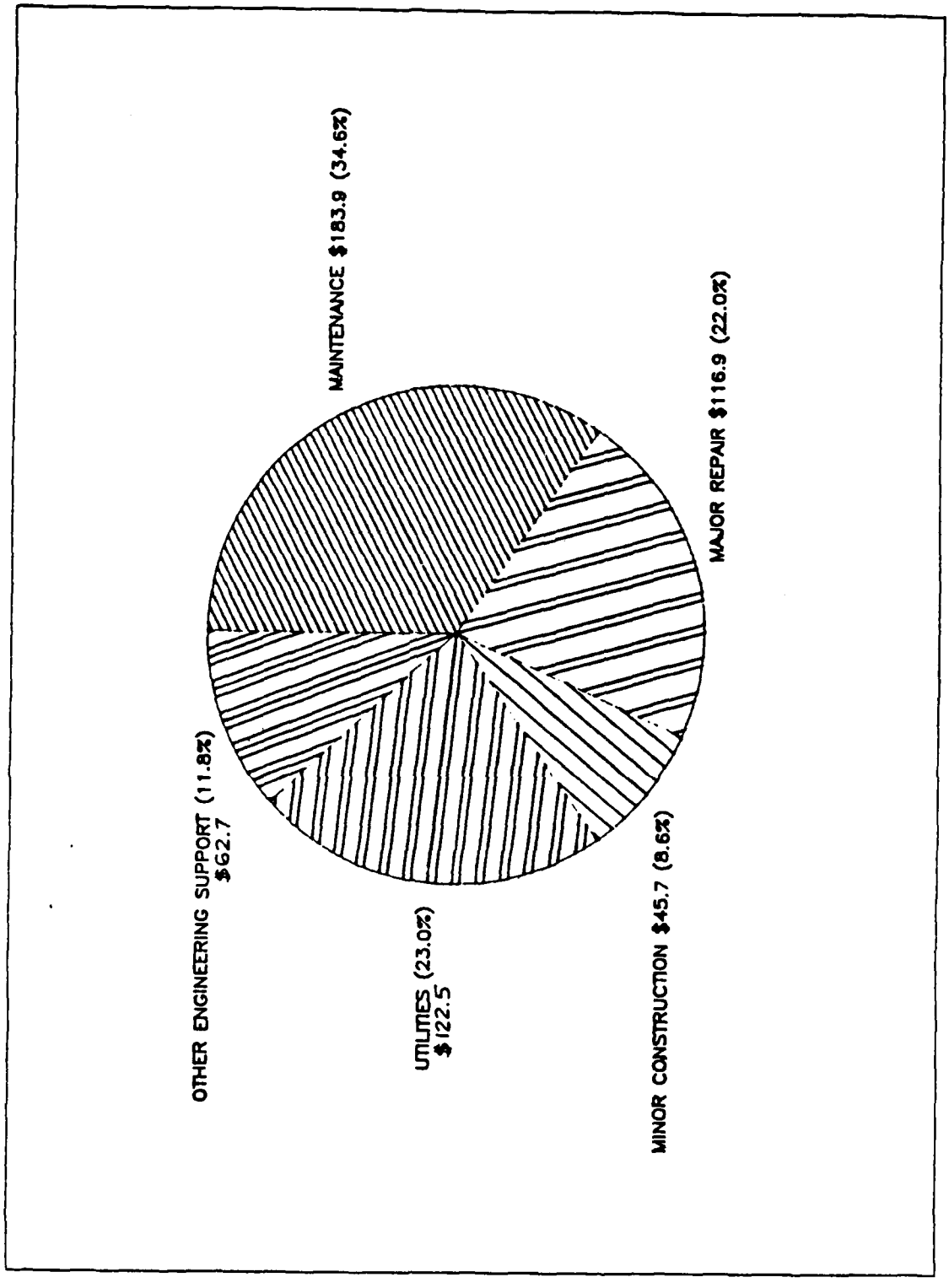

Figure 3.1 Marine Corps RPMA Program Fiscal Year 1987 (Millions of Dollars).

special program projects. Construction projects which exceed $200,000 are under the scope of military construction. Refer to Table 6 for approval thresholds for minor construction. [Ref. 15: pp. 3-3, 3-4] Likewise, M1 are repair projects which can be accomplished with local approval authority, while M2 are repair projects which require approval from higher levels. Maintenance is totally within the local commander's approval authority. Refer to Table 7 for approval thresholds for repair projects. [Ref. 15: p. 4-10].

Since Congress continuously stresses the use of MRP funds for reducing BMAR, CMC established a target for locally approved expenditures for minor construction of 6 percent of the M1 and R1 funds provided in the financial ceiling. Activities desiring to exceed the 6 percent limit must notify CMC of the intent and the amount. [Ref. 16: p. 1-13]

TABLE 6

MINOR CONSTRUCTION PROJECT APPROVAL AUTHORITIES

	CMDR	CMC
Major Activities		
$100,000 or less (R1)	X	
$100,001-$200,000 (R2)		X
$0-$200,000 (R2 special programs)		X
Minor Activities		
$10,000 or less (R1)	X	
$10,001-$200,000 (R2)		X
$0-$200,000 (R2 special programs)		X

CMDR is the Activity Commander
CMC is the Commandant of the Marine Corps

1. **Types of Maintenance**

There are two broad types of maintenance: specific and continual. Both types involve work which is corrective or protective in nature. Both can be estimated using engineered performance standards (EPS).

Specific maintenance is work performed and accounted for under the authority of a specific job order. The job has a beginning and an end. A detailed plan, estimate, and schedule are required before the job is started. Specific maintenance work may occur over a period of time, but it is not of a continuing nature for a specific facility. Examples of specific maintenance include interior and exterior painting, patching and coating roofs, sealcoating pavement, and testing electric switchgear. [Ref. 16: p. 3-4]

TABLE 7

REPAIR PROJECTS APPROVAL AUTHORITIES

	CMDR	CMC	ASN
Major Activities			
$300,000 or less (M1)	X		
$300,001-$3,000,000 (M2)		X	
Over $3,000,000			X
Minor Activities			
$25,000 or less (M1)	X		
$25,001-$3,000,000 (M2)		X	
Major and Minor Activities			
Estimated funded project cost of each facility exceeds $200,000 and 50 percent of the replacement value of the facility.			X

Continual maintenance is work performed and accounted for on a standing job order or open-end contract basis. The job has no definite beginning or end. Continual maintenance is repetitive in nature and extends throughout the year or season. Examples of continual maintenance include grass cutting, emergency service work, snow removal, and preventive maintenance of electrical and mechanical equipment. [Ref. 16: p. 3-4]

2. **Maintenance Standards**

DOD has established maintenance standards upon which the Marine Corps standards are determined. The DOD standards are as follows [Ref. 16: p. 3-5]:

a. Facilities to be used for more than 10 years shall be maintained, as necessary, to preserve the asset and to ensure their most economical and efficient usefulness for an indefinite period.

b. Facilities to be used from 3 to 10 years shall be given maintenance consistent with the projected useful life of the structures or programs to which they are related.

c. Facilities to be used for less than 3 years or only to meet a temporary demand shall be maintained to the minimum acceptable standard without jeopardizing the health and safety of personnel or seriously impairing the accomplishment of the mission.

d. Inactive facilities included in mobilization plans shall be maintained to the extent necessary to assure weather-tightness, structural soundness, and protection against fire and erosion, and to permit reactivation in the period prescribed.

e. Maintenance and repair work, whether performed by contract or in-house personnel, shall be in accordance with applicable Federal, military, or other authorized specifications. All work performed and material used shall be inspected, tested, or otherwise certified for compliance with the provisions of those specifications.

f. All maintenance and repair efforts shall include specific consideration of energy conservation methods and systems. All repairs involving replacements shall include energy conservation requirements.

General maintenance inspection standards are also provided by the Navy in NAVFAC MO-302 [Ref. 17]. Technical guidance for performing specific and continual maintenance are contained in the maintenance and operation MO-100 to MO-322 series of manuals released by the Naval Facilities Engineering Command [Ref. 16: p. 3-6].

C. WORKLOAD DEVELOPMENT

1. Inspection System

Real property inspections are the primary generators of maintenance and repair requirements for an activity. The purposes of inspections are to monitor current programs, reduce the number of breakdowns, reduce the cost of repairs, identify deficiencies in the early stages, maintain a constant flow of work, and initiate corrective action to meet activity standards. Inspections should be planned, scheduled, and performed annually by qualified, trained inspectors and operators. An inspection system includes four types of inspection programs: annual control inspection, preventive maintenance inspection, cyclic maintenance inspection, and operator inspection. [Ref. 16: p. 3-9]

The annual inspection control program integrates data from all four inspections into the long range maintenance and annual work plans. Thus a comprehensive annual control inspection program is necessary to identify total maintenance and repair requirements for an activity. Where in-house capability is lacking or not cost effective, the use of other agencies or outside consultants to perform inspections on specialized systems and components, such as elevators and unfired pressure vessels, is recommended. Control inspections of facilities are scheduled to: [Ref. 16: p. 3-9]

- Assess the effectiveness of current maintenance programs
- Determine physical condition
- Record, cost, and establish a timeframe for correcting deficiencies

- Update the real property inventory

Preventive maintenance inspections are scheduled examinations, minor adjustments, and minor repair to equipment or systems that have no assigned operator. Preventive maintenance is performed when disablement of equipment or a system would do one of the following: [Ref. 16: p. 3-10]

- Endanger life or property.
- Involve high cost or long lead time for replacement.
- Interfere with essential operation of an activity.

Cyclic maintenance inspections are scheduled examinations and immediate repair of recurring minor structural, electrical, or mechanical items in high use facilities. Cyclic maintenance is limited to thirty minutes per task and the use of simple handtools. Examples of cyclic maintenance include tightening hinges, replacing faucet washers, and replacing electrical switches. Items which cannot be repaired are reported to the inspection unit. [Ref. 16: p. 3-10]

Operator inspections are the day-to-day examinations and minor adjustments to equipment accomplished by the assigned operator. Frequency and details are provided in the standard operating procedures for the operator. The operator reports all deficiencies beyond his capacity to the inspection unit. [Ref. 16: p. 3-10]

Deficiencies reported to the inspection unit from preventive, cyclic, or operator inspections are inspected by a qualified person from the inspection unit. The recorded deficiencies are verified and the inspector prepares a form NAVFAC 9-11014 38, Inspector's Report, showing a rough cost estimate for the work required to correct the deficiency. A job order continuation sheet is attached to the report whenever the detailed elements are too voluminous to record on the basic report. The continuation sheet provides essential data to plan and estimate the job. The sheet contains the scope of the job and a sketch or diagram of the location. [Ref. 16: p. 4-3] Items identified on the inspection reports provide input for the activity's Long Range Maintenance Plan.

2. **Long Range Maintenance Plan**

The Long Range Maintenance Plan (LRMP) is a five year forecast of all maintenance and repair work required for maintaining the activity's facilities at the previously identified standards level. The LRMP begins with the current year and is unconstrained with respect to availability of personnel or monetary resources. The plan contains an entry for each line item on the real property inventory to include the

facility identification number, work description, and cost for each of the five years. The plan identifies those items of maintenance chargeable to FCC M and overhead items chargeable to FCC M which are required to support the work. The plan also includes demolition requirements for the activity. [Ref. 16: p. 3-11]

The LRMP is completely updated annually. During the update, the first year of the old plan is deleted and one additional year is added. Costs are escalated to reflect the new current year. The items included in the first year of the old plan which remain unfunded and valid at the end of the first year are identified on the BMAR report. The first year of the new plan becomes the activity's Annual Work Plan for the current year. The LRMP is retained by the activity and is available for review by CMC. The plan is utilized to justify budget submissions to higher levels. The LRMP workload is developed from the following items: [Ref. 16: p. 3-11]

(1) Specific maintenance - M1 recurring work

(2) Continual maintenance - M1 recurring work, preventive and cyclic maintenance

(3) Inspections - M1 and M2 nonrecurring maintenance work

(4) Work requests - M1 and M2 nonrecurring customer and inspector inputs, emergency and service work

(5) Chargeable personnel - inspectors, planners and estimators, maintenance service contracts, scheduling

3. **Annual Work Program**

The annual work program is the portion of the annual work plan that can be accomplished within financial and manpower constraints. The signed program document is the preliminary authorization for undertaking work during the fiscal year. The annual work program reflects the activity's prioritized selection of specific maintenance and repair requirements, anticipated continual requirements, utilities operations, other engineering support, and minor construction. The program includes directly funded and reimbursable work. Considerable engineering judgment is needed to compile the annual work program. The program requires balancing workloads among work centers and deciding whether to use in-house forces or contract out. [Ref. 16: p. 3-15]

The annual work program is further broken down into quarterly work programs. The quarterly program is used for planning, estimating, and scheduling individual jobs. It must take into account seasonal conditions, availability of materials, available work force, and priority. For efficient use of resources, the quarterly program

should be completed at least 30 days prior to the beginning of the quarter. [Ref. 16: p. 3-15]

D. JOB PLANNING AND ESTIMATING

Estimating involves determining the number of hours, cost of hours, and cost of material and equipment required for a job. Planning involves determining the manner and sequence in which the work centers, material, and equipment are required for accomplishing the job. Planners and estimators prepare final estimates for standing job orders and rough estimates for future work programs, work requests, and inspectors' reports. [Ref. 16: p. 4-7]

1. Engineered Performance Standards

Engineered Performance Standards (EPS) designate a standard number of hours normally required to accomplish a task. EPS are based on an average employee of average skill, using average effort, working under average conditions to perform specific tasks following prescribed methods. The standard times include authorized allowances for personal convenience, fatigue, and delays. The Naval Facilities Engineering Command publishes technical manuals in the NAVFAC P-700 series which provide hourly standards for various jobs. Planners and estimators using EPS receive special training to ensure accurate and uniform application of EPS. The use of EPS to the maximum extent possible is encouraged. EPS are used in scheduling, productivity enhancement, and summary reports to management. [Ref. 16: pp. 4-7, 4-8]

2. Cost Application

The scope, work hours, and costs should be continuously reviewed for annual and seasonal standing job orders. Hours and cost estimates should be added to all specific job order continuation sheets. Rough estimates are provided for unfunded minor construction projects and reimburseable work requests. Cost estimates should be applied as follows: [Ref. 16: p. 4-9]

(1) Labor costs shall be computed at the average wage of the applicable work center and accelerated by the percentage specified in the NAVCOMPT Manual, volume 3.

(2) Materials costs shall be based on the price of the item listed in the appropriate supply catalog.

(3) The cost of equipment shall be accumulated to Work Center Code 72 or 73 and shown in the column headed "equipment rental" of the job order form. The hourly rates listed in NAVCOMPT Manual, volume 3, chapter 5, shall be used to compute the cost estimates.

E. RECORDS, REPORTS, AND SURVEYS

1. Facility History and Customer Files

A Facility History File is established for each facility listed on an activity's real property inventory. This file provides information on the work performed on the facility in the past and identifies work to be performed in the future. Documents included in the file are the following: [Ref. 16: pp. 5-3, 5-4]

a. Cover Sheet. A chronological listing of specific work and new construction done to the facility.

b. Inventory Card. A copy of the real property inventory record card prescribed by the current edition of NAVFAC P-78 (Real Property Inventory Instructions for Preparation and Distribution of Property Records Cards). Detailed information (e.g., number of roof squares, number and sizes of windows, etc.) of the physical components not provided in the basic card may be added on the reverse side of the card.

c. Job Orders and Service Contracts. A copy of microfiche or computer data bank record of each job or contract for construction, repair, or maintenance of the facility. These records shall be replaced with subsequent authorizations for similar work.

d. Inspector's Reports. Reports completed for maintenance and repair revealed during the most recent control inspection.

e. Emergency/Service Tickets. A separate history file for each facility shall be maintained to compile emergency and service tickets. A periodic review of these files should be conducted to determine the frequency of similar jobs for possible major deficiencies or causes of abnormally high costs. The files may be cleared of emergency/service tickets annually.

A separate customer file should be established for each customer. A customer is an activity, component of an activity, unit, organization, or tenant which is authorized by the activity commander to request facilities support. The customer file should include work requests and job orders used for estimating required maintenance services. [Ref. 16: p. 5-4]

2. BMAR Report and Projects Plan

The basis for the Marine Corps' annual BMAR report to the DON and subsequently to Congress is each activity's BMAR Report and Projects Plan, report symbol DN 11014-01. Each major and minor shore activity is required to submit the BMAR report annually to CMC not later than 10 October each year. This report is the end-of-the-fiscal-year measurement of the maintenance and repair work that remained as a firm requirement of the annual plan but which could not be accomplished during the fiscal year because of lack of resources. [Ref. 16: pp. 5-5, 5-6]

BMAR items are identified by deficiency codes. The report includes items of maintenance and repair and demolition which where part of the annual plan. The report does not include minor construction. Coding criteria for the BMAR Report and Projects Plan are as follows: [Ref. 16: pp. 5-5, 5-6]

(1) Code 1, Maintenance and Minor Repair Work. Consists of all maintenance and repair items whose estimated cost is within the local commander's approval authority described in the current edition of MCO P11000.5. These are facilities deficiencies which should have been corrected during the fiscal year with locally budgeted (Subfunctional Code M1) funds but were not because of lack of resources. When a facility required construction work as well as maintenance and repair, only the maintenance and repair portion will be reported.

(2) Code 2, Major Repair Work (Subfunctional Code M2). Consists of all repair items whose estimated cost is above the local commander's approval authority described in the current edition of MCO P11000.5. After Headquarters Marine Corps validation, all BMAR Code 2 items will be considered for inclusion in a current or future year Headquarters Marine Corps facilities projects program. When a facility required construction work as well as major repair work, only the major repair portion will be reported.

(3) Code 3, Demolition. Consists of those items of demolition of excess facilities (class 2 real property), regardless of cost. The estimated cost of a demolition item should include the cost of work to restore the site to a condition equivalent to the surroundings. This category applies only to excess facilities, but does not apply to demolition required because of construction or repair.

Project plans for the current year through budget year plus two are submitted along with the BMAR report. The project plans should reflect the unconstrained requirements as shown in the activity's LRMP. The form and codes used for the project plan are the same as those used for the BMAR report. [Ref. 16: p. 5-6] The form includes blocks for identifying the following information: line number, subunit

identification code, construction type, work description, deficiency code, facility number, DOD category code, cost account code, prior submittal, fiscal year, function/subfunction code, PB-29 line number, validated rating, project number, and cost. [Ref. 16: pp. C-6, C-7]

CMC requires activities to submit a quarterly BMAR update report to Headquarters Marine Corps within ten days after the end of each quarter. This report is designed to provide an update on separate M1 and M2 actions, which change BMAR, during the fiscal year. The quarterly report identifies new deficiencies during the current fiscal year, new and old BMAR which received funding, and value of BMAR and unfunded new deficiencies at the end of the reporting period. [Ref. 16: pp. C-15, C-16]

3. **Internal Reports**

Several internal facilities maintenance management reports are available to analyze the maintenance organization operations. The first report is the Estimate and Performance Analysis. This report provides a monthly summary, by work center, of estimated and actual productive labor hours and costs, material costs, and equipment costs for specific job orders completed. The second report is the Labor Analysis. The Labor Analysis is a monthly report which provides, by work center, the productive overhead hours, year-to-date cumulative hours for productive overhead, and percentages for each. The third report is the Completed Specific Job Orders. This report summarizes estimated and actual data for each closed specific job order. It identifies the hours, labor cost, material cost, and total cost. The fourth report is the Monthly Standing Job Order Status. This monthly report shows the status of standing job orders, with respect to actual hours, material cost, and labor cost for the period, in relation to estimated levels for the fiscal year. The final report is called the Work Status. The Work Status report is manually prepared and identifies the number of personnel assignments in each of the areas of standing jobs, specific jobs, unscheduled work, and the number of shop days. [Ref. 16: pp. 5-9, 5-10, C-19 - C-33]

4. **Surveys and Validations**

Staff representatives of CMC conduct annual on-site surveys to evaluate the effectiveness of the activity's RPMA program. Specific areas reviewed include activity inspection plans, LRMP, annual work plan, annual and quarterly work programs, internal reports, work requests, work flow and staffing patterns, job orders, and general physical condition of facilities. [Ref. 16: p. 5-11]

Each activity's BMAR Report and Project Plan is reviewed by CMC. An on-site validation for all code 2 and code 3 items on the report is scheduled within 60 days. Validation is the process of physically inspecting all code 2 and code 3 projects, insuring all code criteria are met, and assigning points to each project. The validation team consists of at least one representative from CMC and one representative from the activity. Code 1 deficiencies are spot checked but not rated. [Ref. 16: p. 5-12]

The validation process provides CMC with first hand information on projects. It also is used as a method of prioritizing the activity's projects. The criteria used by CMC to rate each project have been revised several times. The current project survey data sheets used for minor construction and major repair are provided in Appendix D. Special program project survey data sheets are used for projects which fall into the area of fire protection, environmental, natural resources, OSHA, energy and utilities, and safety. A numerical weighted system is applied to the projects. Major repair projects receive variable points based on the judgment of the evaluator for the following items [Ref. 15: p. E-4]:

- Command priority (What priority is this project in relation to all other projects at the command?)
- Facility use (Is the facility primarily used for operations, training, maintenance, utilities, habitability, storage, MWR, or other?)
- Savings or cost increase factor (Points are given for three items: cost will escalate considerably if project is delayed one year, project is self amortizing (i.e., the cost of the project is expected to be recovered by some financial return), and delaying the project will cause deterioration of other assets.)
- Impact on mission if deferred one year (How much will the project impact on the mission of the activity?)
- Project generated to support CMC program, eliminate life threat situation, or externally directed (Was the project initiated as a result of one of these three items?)

Minor construction projects receive variable points for the following items [Ref. 15: p. E-3]:

- Command priority (What priority is this project in relation to all other projects at the command?)
- Operational influence (Does the project directly, or indirectly influence, or have no influence on the activity's operation?)
- Facility use (Is the facility primarily used for operations, training, maintenance, utilities, habitability, storage, MWR, or other?)
- Requirement is part of a CMC directed program
- Project is due to a change in mission

- Project is self amortizing within five years (i.e., the cost of the project is expected to be recovered by some financial return)
- Project is being done concurrently with a major repair project

Major repair and minor construction projects are approved for inclusion in the program primarily on the basis of the total survey score. Low scoring projects are not normally funded. Validated projects are normally planned for execution two years from the year of validation. For example, the November 1986 validation cycle validated fiscal year 1988 projects. Once validated, projects are not revalidated in subsequent fiscal years. Project numbers reflect the planned year of execution. [Ref. 15: pp. 2-5, 2-6]

Special program projects are concurrently validated with major repair and minor construction projects. The survey data sheets are provided to the respective special program manager at CMC. The score from the validation survey is not always the deciding factor for prioritizing special projects. Program managers may apply other factors which override the survey score. Activities are notified by message of special projects approved for design and funding during the current fiscal year. The prioritized list is not perpetual and projects not selected must be resubmitted the following fiscal year. [Ref. 15: p. 2-5]

Supplemental projects may be submitted to CMC after the on-site surveys are completed. Requests for supplemental project approval must include a detailed explanation of the circumstance generating the requirement and required documentation. Circumstances in which a supplemental project may be submitted are: [Ref. 15: p. 2-6]

(1) The project is urgently required to support a change in mission.

(2) Restoration or repair is required immediately because of an act of God or similar circumstance beyond the control of the activity commander.

(3) The project is self amortizing (i.e., the cost of the project is expected to be recovered by some financial return) within three years following the completion of the project.

(4) A hazard to life and property equating to the Occupational and Health Act, Risk Assessment Code (RAC) I, exists and cannot be corrected without the requested project.

(5) The project is urgently required due to an unforseen requirement.

F. BMAR MANAGEMENT AT HEADQUARTERS, MARINE CORPS (HQMC)

The Real Property Maintenance Activities Section, Facilities Branch, Facilities and Services Division, Installations and Logistics Department is the responsible office in the Marine Corps for administering the RPMA program. Marine Corps Order P11000.7 provides the guidance for BMAR.

1. Definition and BMAR Report

The Marine Corps defines BMAR as follows [Ref. 16: p. A-3]:

> End of fiscal year measurement of maintenance and repair work remaining as a firm requirement of the annual plan but which lack of resources prohibit accomplishment in that fiscal year.

The Marine Corps' BMAR objective is to reach the fiscal year 1978 containment level of $105.9 million. Since fiscal year 1978, the budgeting and projects plans have continuously reflected the desire to reach the containment level. [Ref. 14: p. 24]

Normally in August of each year, the prior year BMAR report is distributed to each activity for updating. By 10 October, HQMC receives the updated prior year BMAR report along with the new BMAR Report and Projects Plan. Both are reviewed and scrubbed for duplication and to ensure end of year funded projects are not included. Each activity's BMAR file at HQMC is updated to reflect the changes and the new BMAR information. A copy of the updated BMAR files are sent out to the activities for reconciliation. [Ref. 18]

2. HQMC Facilities Projects Program

The HQMC Facilities Projects Program is a centrally managed program for prioritizing and funding major repair (M2), minor construction (R2), and equipment installation projects at Marine Corps activities. Funds provide for engineering investigations and studies related to the projects, design, and minor acquisition of land when necessary. [Ref. 15: pp. 2-1, 2-2] Major repair (M2) projects are authorized for design during the validation process. HQMC approves minor construction (R2) and special programs projects for architectural and engineering (A&E) design by message to field activities. Normally, A&E funds are provided to the activities prior to the on-site surveys. This allows the activities to execute design contracts upon completion of validation and begin design immediately. After validation, the execution of the HQMC Facilities Projects Program follows these steps in sequence: [Ref. 15: p. 2-7]

(1) HQMC approves projects for design and provides A&E funds.

(2) Activities advise HQMC of date design will be ready and priority.

(3) Activities submit required documentation for all projects.

(4) Activities advise HQMC of low bids and request funds.

(5) HQMC allocates funds to activities.

(6) Activities execute contracts and obligate funds.

(7) Activities and HQMC process change orders which are above the contingency ceiling.

3. **Marine Corps BMAR Model**

a. Old Model

The old BMAR model, which was used through the fiscal year 1986 budget, was very crude. The user imputed the current year BMAR, the maintenance and repair funds budgeted for each year of the forecast, and the appropriate inflation escalator for each year of the forecast. The output was the projected BMAR for each year of the forecast. The old model used the $BMAR_i$, where "i" is the fiscal year, to estimate $BMAR_{i+1}$ and then used $BMAR_{i+1}$ to estimate $BMAR_{i+2}$, without considering changes in Marine Corps plant property or historical trend information. [Ref. 19]

b. Current Model

The current BMAR model, which was used for the fiscal year 1987 and 1988/1989 budgets, is more accurate in BMAR projections. The new model is a nonlinear regression model written in Lotus 1-2-3. Output can be provided in two different ways: (1) if the budgeted maintenance and repair funding is identified for all years, the model will project the BMAR for each year, and/or (2) if the BMAR goal for each year is identified, the model will project the maintenance and repair funding required to reach the BMAR goal. User input for the current model includes: [Ref. 19]

- Historical BMAR (last five years was used for last budget)
- Historical Current Plant Value (CPV)
- Historical CPV escalators
- MILCON starts/deletes (previous two years and future forecast period)
- JFIP starts (previous one year and future forecast period)
- Military Statistical Cost (historical and future)
- Future BMAR deterioration factor (further deterioration, if problem is not corrected, will result in a constant annual increase of 3 percent of BMAR)
- Desired BMAR profile for forecast period
- Maintenance and repair funding profile for forecast period
- Escalators for O&MMC, MPMC, and MILCON (historical and forecast periods)
- Regression Information

The current BMAR model uses the following methodology [Ref. 19]:

(1) All inputs are adjusted to fiscal year 1978 dollars.

(2) CPV, in 1978 dollars, is estimated for the forecast period using MILCON and JFIP data, military statistical cost, and demolition data.

(3) For historical data, NEW_i (total requirement for maintenance and repair for fiscal year i) is calculated as:

$$NEW_i = BMAR_i - BMAR_{i-1} + FA_i$$

where FA_i is the maintenance and repair funds applied or budgeted for fiscal year i. R_i (regression for fiscal year i) is calculated as:

$$R_i = NEW_i / CPV_{i-1}$$

(4) A nonlinear curve fitting program is used to fit the historic R_i to a curve of the form

$$R_i = 1 / (a + b*c^{i)}$$

and the resultant equation is used to calculate the forecast R_i 's

(5) The R_i 's are then used with the projected CPV_i 's to predict NEW_i for the forecast period using:

$$NEW_i = CPV_{i-1} * R_i$$

(6) The desired funding or BMAR profiles are computed using:

$$BMAR_i = BMAR_{i-1} + NEW_i - FA_i$$

or equivalently

$$FA_i = BMAR_{i-1} + NEW_i - BMAR_i$$

(7) After the calculations are complete, all results are escalated to then-year dollars.

The nonlinear logistics curve demonstrates the relationship between CPV and maintenance and repair requirements. In the early 1980's, increased emphasis, better reporting, and increased availability of funds resulted in rapid growth of maintenance and repair requirements. Continued adequate funding caused the maintenance and repair requirements rate of growth to slacken. Other types of curves were investigated, but they did not have the subjective appeal of the logistics curve.

The Marine Corps found the logistics curve best represented the type of growth rate being experienced and it produced reasonable numbers. [Ref. 19]

The advantages of the BMAR model include the following. It relates maintenance and repair requirements to CPV, captures historical trends in facilities maintenance, is easy to use (regression and escalator data are updated annually by LPA-1 analysts), and is flexible to use for what-if profiles. On the disadvantage side, the model is based on a historical relationship between CPV and maintenance, which is very crude. It requires an assumption as to the trend of maintenance and repair requirements. [Ref. 19]

The Marine Corps recently discussed possible improvement to the current BMAR model with representatives from the Logistics Management Institute. The Marine Corps is investigating age and size of buildings to use as possible additional regression predictors. If successful, the model will be revised to use multiple regression predictors. [Ref. 19]

HQMC uses the BMAR model during preparation of the Program Objective Memorandum (POM) to predict total maintenance and repair funding required to get to the $105.9 million BMAR goal. The identified maintenance and repair funding profile is then reviewed for executability. Decisions are made as to whether the field activities could actually execute a program which would have the desired funds. If not, a determination is made concerning how much would be a reasonable request. Finally, a decision is made on the breakdown of the total requested maintenance and repair funding between M1 and M2 requirements. [Ref. 20]

4. **The Future**

The Marine Corps anticipates several unpredictable variables to effect future maintenance and repair requirements and BMAR. One variable is the replacement of underground utility systems. Another variable is the replacement of leaking underground fuel storage tanks. State environmental regulations require tanks to be dug up, the bad soil removed, and new tanks installed. Other variables are the disposal of hazardous waste and possible violations of other environmental regulations. Future plans in the area of BMAR include doing a better job of planning, rolling up M1 projects on the BMAR report, tightening up the validation and scoring procedures, and ensuring all required documents for HQMC funded projects are provided to HQMC. [Ref. 21]

IV. BMAR MANAGEMENT IN OTHER SERVICES

A. DEPARTMENT OF THE NAVY

1. Definition and Goal

The Department of the Navy (DON) divides maintenance and repair backlog into two categories--critical and deferrable. For the purpose of internal Navy use, BMAR is equivalent to the critical backlog reported by activities on the Annual Inspection Summary (AIS). The figures reported to OSD and Congress as BMAR reflect only the critical backlog. [Ref. 22: Encl 1, p. 1] Critical backlog of maintenance and repair is defined as follows [Ref. 23: p. 3]:

> Maintenance and repair deficiencies for which corrective action should be taken immediately or programmed for accomplishment within the current fiscal year. It must also meet one or more of the following criteria:
>
> (1) Catastrophic Environmental--A technically valid job to correct a facility maintenance and repair deficiency, where failure to perform the job would result in immediate catastrophic environmental damage, such as, a major oil spill.
>
> (2) Loss of Mission--A technically valid job to correct a facility maintenance and repair deficiency, where failure to perform the job would significantly contribute to major interference or total loss of an assigned mission capability. Loss of mission should reflect either a C3 or C4 readiness rating as defined in OPNAVINST 3501.167A.
>
> (3) Life or Death Safety--A technically valid job to correct a facility maintenance and repair deficiency, where failure to perform the job would immediately jeopardize human life.
>
> (4) Quality of Life--A technically valid job to correct a facility maintenance and repair deficiency, where failure to perform the job degrades either the habitability of the barracks or the working conditions in the immediate work areas.

Deferrable maintenance and repair backlog is the estimated dollar value of maintenance and repair deficiencies for a given fiscal year which are of a deferrable nature. That is, the corrective action is not immediately warranted and does not meet the critical criteria. [Ref. 22: Encl 1, p. 2]

In October 1986, the Chief of Naval Operations (CNO) established an objective to reduce the critical backlog to zero by the end of fiscal year 1994 and established priority orders for investment categories (IC) (cf. Table 8). Additional objectives were to contain the deferrable backlog to the fiscal year 1985 level and execute the Shore Facility Life Extension Program (Shore FLEP). [Ref. 22: p. 3]

TABLE 8

DON INVESTMENT CATEGORY PRIORITY FOR REDUCING BACKLOG

	Investment Category	Priority High	Med	Low
01	Aviation Operational	X		
02	Communication Operational			X
03	Waterfront Operational	X		
04	Other Operational			X
05	Training	X		
06	Aviation Maintenance Production		X	
07	Shipyard Maintenance Production		X	
08	Other Maintenance Production			X
09	RDT&E			X
10	POL Supply and Storage		X	
11	Ammo Supply and Storage		X	
12	Other Supply and Storage			X
13	Medical		X	
14	Administrative			X
15	Troop Housing and Messing	X		
16	Other Personnel Support		X	
17	Utilities	X		
18	Real Estate and Grounds			X

2. **Annual Inspection Summary**

The Annual Inspection Summary (AIS) provides real property condition data in support of programming and budgeting for MRP. All shore activities are required to submit the following two reports by 15 October each year: (1) Type "A" AIS-Maintenance and Repair of Real Property (MRRP) Deficiency List (OPNAV 11010/8) and (2) Type "A" AIS-Cost Account Summary (OPNAV 11010/9). The AIS-MRRP deficiency list includes all unfunded maintenance and repair deficiencies. The following

elements are identified on the report: deficiency item number, deficiency description, facility number, property record number, category code, cost account, investment category, deficiency code, deficiency type, current cost estimate, project number, inspection status, and claimant's notes. The AIS-Cost Account Summary displays the results of the AIS-MRRP. It provides a list of the unfunded deficiencies by fund source, resource sponsor, investment category, cost account, and critical or deferrable type. The AISs reflect critical and total maintenance and repair backlog as of 30 September and are forwarded to the first level of review. [Ref. 22: p. 2 and Encl 2]

Claimants are responsible for the overall coordination, review, validation, and consolidation of shore activities' AIS reports. After validation, claimants prepare consolidated AIS-Cost Account Summary and AIS-Narrative Assessment reports for each fund source. These AIS reports are submitted to CNO (OP-44) and NAVFACENGCOM (Code 1003) by 1 December each year. The AIS-Cost Account Summary is the same format used by the shore activities. The AIS-Narrative Assessment report is required for each unique fund source and IC combination. The report identifies the fund source, IC, total cost of critical backlog last year, total cost of deferrable backlog last year, funding last year, total cost critical backlog this year, total cost deferrable backlog this year, condition rating, specific mission impact, and claimant objective. [Ref. 22: p. 4 and Encl 3]

Claimants, whose MRP is funded by Operations and Maintenance, Navy (O&MN), are required to submit execution data for subfunctional categories M1, M2, R1, and R2. The MRP execution report covers the just ended fiscal year and is submitted to CNO (OP-442E) by 15 December each year. The report is used to evaluate progress toward the backlog reduction goals established by CNO. The execution report indicates the quantity of work units by cost account; total cost (excluding military labor) by cost account; and summary cost data broken down into civilian labor, contract, other, and military labor. The cost identified should be the certified obligations as reported to NAVCOMPT. [Ref. 23: Encl 3]

During preparation of the POM, CNO utilizes the AIS and execution reports to prepare a comprehensive review of the DON requirements for MRP. The review includes an assessment of the condition of facilities, a statement of the potential impact on readiness, compliance with Shore FLEP objectives for critical backlog reduction, and identification of resources required to achieve MRP objectives. [Ref. 23: p. 4]

3. Navy BMAR Model

The Navy BMAR model has been used for the past three years to provide projections for maintenance and repair requirements and BMAR. It is used for the POM process and revised for subsequent budget submissions. The current BMAR figure is taken from the AIS reports. User input for the model includes: [Ref. 24]

- Current inflation rates
- Current MILCON inflation rates
- Historical CPV
- Historical BMAR
- Maintenance and repair funding profile for forecast period

The BMAR model uses the following methodology [Ref. 24]:

(1) CPV_i (where "i" is the fiscal year) is calculated for outyears as:

$$MILCON + (CPV_{i-1} / 100 + 1\% (MILCON))$$

(2) The model uses prior year's ending BMAR as next year's beginning BMAR.

(3) The following items are calculated:

(a) Inflation = Beginning BMAR * Inflation rate

(b) Deterioration = Beginning BMAR * 3%

(c) New Finds = CPV * .44%

(4) The beginning BMAR, inflation, deterioration, and new finds are added for a BMAR subtotal.

(5) Cost of ownership (defined in next section) is calculated as:

$$CPV * 1.2\%$$

(6) Deferred funds are calculated as:

$$(\text{Current MRRP funding} - \text{Cost of ownership}) * 1\%$$

(7) The cost of ownership and deferred funds are subtracted from the MRRP funding for a funding subtotal.

(8) The funding subtotal is subtracted from the BMAR subtotal to determine the year end BMAR. This amount becomes the beginning BMAR for the next year.

The inflation rates are updated for each budget cycle. The model is evaluated every year to see how closely it follows the actual trend. The advantages of the model are ease in use, flexibility in evaluating effects on BMAR for cuts or additional fundings, and ease in determining if reduced BMAR in the future is a realistic goal under the funding profile. The main disadvantage of the model is that it does not fit all types of activities. The model fits the pattern of the large activities, but the smaller activities need a simpler model. [Ref. 24]

4. Navy Management

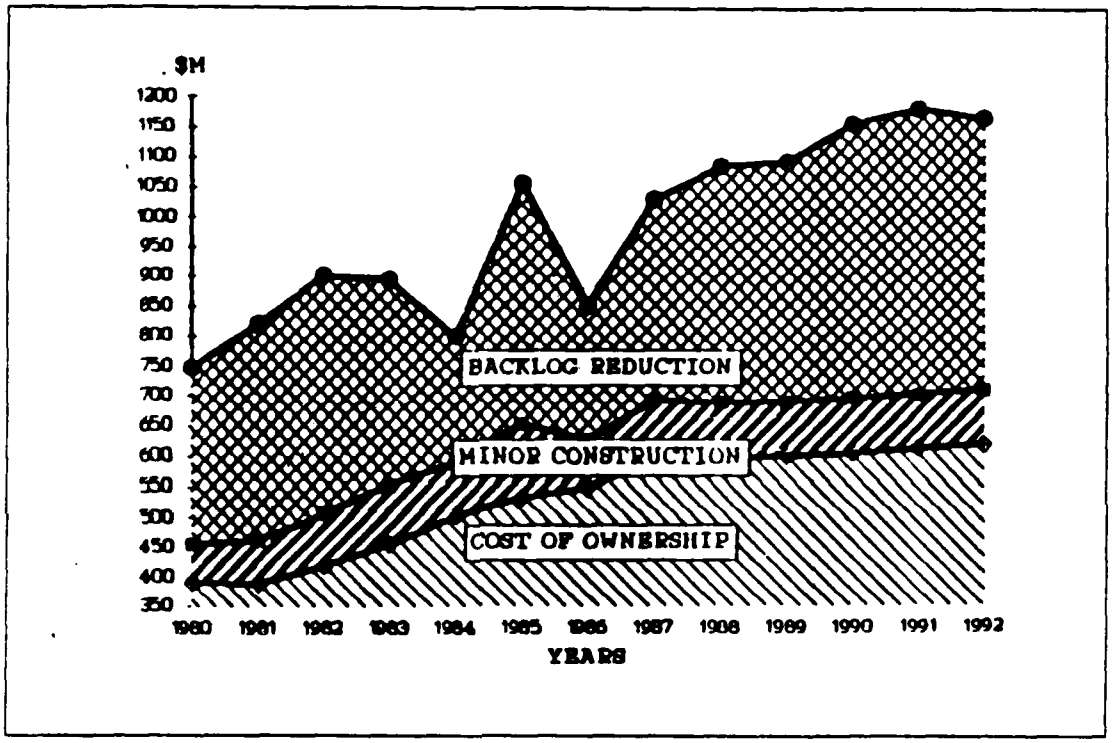

Figure 4.1 DON Maintenance of Real Property in Constant 1987 Dollars.

Shore FLEP is designed to attain the objective of improved readiness through targeted use of Replacement or Modernization Military Construction (R/M MILCON) and MRP projects to correct critical maintenance and repair deficiencies. [Ref. 23: Encl 2] Figure 4.1 shows the budgeted MRP funding broken into three bands. The bottom band, called the cost of ownership, represents the basic functions such as preventive maintenance, dredging, and minor repairs that must be accomplished to keep the shore facilities in operation. The second band is for O&MN funded minor

construction. Minor construction is limited to 10 percent of the total MRP. The top band represents the amount available for backlog reduction. DON has made significant changes in how O&MN funds are spent for backlog reduction under Shore FLEP. [Ref. 25: pp. 25, 26] DON prioritized backlog reduction goals by IC, with emphasis on high savings to investment ratios. DON also assessed the condition of facilities and the effects on operational readiness. Table 8 shows the priority sequence for reducing the critical backlog under Shore FLEP. [Ref. 23: Encl 2]

B. DEPARTMENT OF THE AIR FORCE

1. Definition and Goal

The Air Force has a large investment in its physical plant. The Air Force has over 1,200 installations, of which 138 are major installations. The physical plant includes 500 million square feet of buildings, 250 million square yards of airfield pavements, 12,600 miles of other pavements, and 10.6 million acres of land; and it has a replacement value of $138 billion (excluding land and family housing). [Ref. 26: p. 1]

The Air Force BMAR is a measure of deferred contract facility projects. The Air Force defines BMAR as [Ref. 27: p. 91]:

> The backlog of maintenance and repair is the measurement (in dollar value) of those maintenance and repair (EEIC 521 and 522 only) facility projects-by-contract which are validated and needed to be accomplished in a previous fiscal year but could not be due to insufficient resources, for example, inadequate obligation authority. Also, the project must still be a current, valid requirement.

The Air Force MRP objectives are preserving the facility investment, improving the living and working conditions, and supporting the expanded base force structure. [Ref. 26: p. 1] While the Air Force has no specific BMAR goal, it has a goal of providing Base Civil Engineers with the resources necessary to implement a balanced maintenance and repair program. [Ref. 28]

2. Civil Engineering Contract Reporting System

The Civil Engineering Contract Reporting System (CECORS) is an automated system which provides the current status of all projects or contract requirements. The data file is updated at the base level as changes occur and is transmitted monthly to the major command (MAJCOM) and Headquarters, United States Air Force (HQ USAF) by the CECORS Detail Transactions Report. CECORS reports all facility projects-by-contract validated for accomplishment in the current fiscal year and the following six years. It also contains the prior fiscal year projects which are still active.

Valid projects which will not be accomplished because of resource constraints are identified on the CECORS by special codes. [Ref. 27: p. 91]

Real property maintenance requirements are identified by sources internal and external to the Base Civil Engineering. Work is identified internally by the planner, technicians, craftsmen, engineer managers, fire department inspectors, and military family housing inspectors. Work is identified externally by building managers, commanders, committees, higher headquarters, and other government agencies. [Ref. 29: p. 2]

The requested work is reviewed and validated. An assessment is made to determine the correct programming approach and funding source. In programming, the urgency, scope, and cost of the work are considered. Local base civil engineering personnel can authorize all recurring work and routine maintenance and repair. All minor construction and maintenance by contract projects are provided to the installation's decision making body called the facilities board. [Ref. 29: p. 2]

The facilities board approves the in-service work plan, validates the projects, and prioritizes the maintenance-by-contract projects. During the validation and approval process, line item control is maintained by the facilities board. Projects beyond the current fiscal year are validated as early as possible. [Ref. 27: pp. 91, 92]

The CECORS includes the project request number, project description, real property category, program fiscal year, construction action suffix, elements of expense investment code, project identifier civil engineer code, major force program, program identifier civil engineer code, total estimated cost, obligation authority amount, contract award value, and real property type construction code. The CECORS Detail Transaction Report is due at the MAJCOM by the 5th day of each month and is due at HQ USAF by the 21st day of each month. The end-of-the-fiscal-year report is due by 15 October to the MAJCOM and by 24 October to HQ USAF. [Ref. 27: pp. 92, 93] All validated maintenance and repair projects which should have been accomplished, but were deferred, are assigned the project identifier civil engineer code of "D". The base civil engineer is responsible for the continuous review of the CECORS list of requirements. [Ref. 28]

3. **Air Force BMAR Model**

The model is on Lotus 1-2-3 spreadsheet and is used to predict future BMAR. The current model has been used since the early 1980's. The Air Force has found the predicted BMARs have been very close to actuals over the years. User input for the model includes: [Ref. 28]

- Current inflation rates
- Maintenance and repair funding profile for forecast period
- Minor construction funding profile for the period
- Estimated migration (realignment of funds from other operations and maintenance programs) amount for the period
- Minor construction factor (percentage of total funding used for minor construction instead of maintenance and repair) for the period

The BMAR model uses the following methodology [Ref. 28]:

(1) The beginning BMAR is taken from the CECORS.

(2) Deterioration is calculated as:

Beginning BMAR * 3%

(3) Inflation is calculated as:

Beginning BMAR * Inflation rate

(4) The maintenance and repair requirement is identified (using baseline year of 1984).

(5) The maintenance and repair requirement and minor construction requirement are added for total new requirement.

(6) Beginning BMAR, deterioration, inflation, and total new requirement are added for total maintenance and repair requirement.

(7) Maintenance funding, repair funding, minor construction funding, and estimated migration are added for total funding.

(8) Maintenance and repair funding applied is calculated as:

Total funding * (1 - minor construction factor)

(9) Ending BMAR is calculated as:

Total maintenance and repair requirement - maintenance and repair funding - minor construction funding

(10) The ending BMAR becomes the beginning BMAR for the following year.

To reduce BMAR, budget year funding must first exceed the level of funding needed for current year maintenance and repair requirements and deterioration. The recurring requirement is the key variable in the BMAR model. Unfortunately, no

absolute criteria have been established for determining the recurring requirement. BMAR has been used to justify the real property maintenance budget to Congress. However, BMAR is only a relative indicator of funding adequacy. [Ref. 26: pp. 4, 5]

4. Air Force Management

During the 1970's, the Air Staff centrally managed project funding. As the program increased, decision making for projects became more decentralized. Today, each of the 15 major commands manages the facility project dollars and apportions funds to the bases. [Ref. 26: p. 7]

In the early 1980's, RPMA funds were consolidated into a single program package for the POM and budget cycle. The entire program came under close scrutiny during deliberations and it became difficult to justify sufficient facility project funding. Currently, RPMA funds are divided into two program packages--one for fixed costs and one for the variable program. The fixed costs are the essential requirements such as in-house labor, utilities, supplies, and services. [Ref. 26: pp. 7, 8] The fixed costs program represents about 80 percent of the RPMA. During the budget, the Air Staff reprices funding estimates for the fixed program based on the latest execution experience. The variable program includes the facility maintenance and repair projects. As a result of this change, only the variable program undergoes close scrutiny during the budget process. The level of funding available for the variable program is constrained due to the amount of total obligation authority provided for the overall Air Force operation and maintenance appropriation. [Ref. 29: pp. 3, 4]

BMAR and new project costs are developed using sound engineering estimating methods. The accuracy depends on the stage of the project's life. Costing done early in the project life is less accurate than costing when a project's design is complete. Air Force BMAR includes costs of projects in all stages of life. [Ref. 29: p. 5]

C. DEPARTMENT OF THE ARMY

1. Definition and Goal

The Army's physical plant is large and complex. The Army has 206 major installations and over 2,000 subactivities. The physical plant includes 189,000 buildings or 1.1 billion square feet, 559 million square yards of surfaced area, and 12.4 million acres of land; and it has a replacement value of $175 billion (excluding land). [Refs. 30,31: pp. 1, 1-1] The Army defines BMAR as follows [Ref. 32: Glossary]:

The end of the FY measurement of M&R work remaining as an unconstrained requirement, but because of limited resources accomplishment was prohibited in that FY. (In this sense, accomplishment means obligation of work started by in-house civilian or military personnel.) BMAR is synonymous with deferred requirements and includes those resources required to correct facility deficiencies.

The Army has a goal of keeping BMAR at a "manageable level". A "manageable level" is defined as 20 percent of the annual recurring requirements for maintenance and repair. The Army has been able to reduce the BMAR significantly since 1982 because of increased fiscal support, favorable exchange rates, and improved management techniques. [Ref. 30: p. 1]

2. **Unconstrained Requirements Report and Direct Backlog Status Report**

The Unconstrained Requirements Report (URR) and the Direct Backlog Status Report are the primary reports submitted to the Department of the Army (DA). The facilities engineer at each installation and activity prepares the URR for submission to its major command (MACOM) headquarters. The URR shows the total unconstrained requirements needed to operate and maintain the installation's real property. Each MACOM prepares three separate consolidated reports covering budget year, budget year plus one, and budget year plus two for each appropriation. The reports are reviewed for accuracy before submission to Headquarters DA (HQDA) by 15 August each year. [Ref. 32: p. 3-1]

The URR (DA Form 4223-R) is divided into three parts. The first part includes the functional category, unit of measure, number of units, annual recurring requirements (ARR), one-time requirements, fiscal year total requirements, BMAR, grand total requirements, total funding available, and unfunded requirements. The second part is a summary of the same elements broken down into operation of utilities, maintenance and repair, minor construction, and engineer support. The third part is a breakdown of unfunded requirements into the functional category, recurring non-BMAR, potential BMAR, and deferred BMAR.

The Direct Backlog Status Report (DA Form 4954-R) is a multiple use form designed for submitting the following component data: (1) quarterly direct BMAR obligations, (2) fiscal year direct unfinanced BMAR, and (3) fiscal year summary analysis of direct backlog changes. A separate component report is required for each BMAR appropriation. The quarterly direct BMAR obligations report includes the following: facility category; construction category code; BMAR ending 30 September; and quarterly cumulative obligations for permanent facilities, semi-permanent facilities,

temporary facilities, and total. The fiscal year direct unfinanced BMAR includes the same elements except the quarterly cumulative obligations for facilities is replaced with fiscal year unfinanced requirements. The fiscal year summary analysis of direct backlog changes uses only page 5 of the form. The information required for the summary analysis is the beginning BMAR on 1 October; projects financed; projects dropped for other reasons; cost changes from beginning BMAR to end of year BMAR; projects added to BMAR during the year; ending BMAR on 30 September; amount of BMAR included for temporary facilities; and BMAR programmed for accomplishment during budget year, budget year plus one, and total.

3. **Army BMAR Rollover Model**

The Army has been using the rollover model for over ten years. During that time, the model has been fairly accurate in projecting outyear BMAR. The model separately calculates BMAR for each of the 16 major commands. The small commands are kept at a zero BMAR level because the total dollars available to the commands are very small and they cannot handle large dollar expenditures for maintenance and repair. User input for the model includes: [Ref. 33]

- Currency exchange rates
- Current inflation rates
- One-time requirements
- Direct funding profile for forecast period
- Estimated migration (realignment of funds from other operations and maintenance programs, Military Construction, Army, and foreign governments) for period
- MILCON profile for period
- Estimated cost advantage for period
- Current BMAR
- Annual recurring requirements

The model uses the following methodology [Ref. 33]:

(1) Deterioration is calculated as:

Carryover BMAR * 3%

(2) Inflation is calculated as:

Carryover BMAR * Inflation rate

(3) Deterioration, inflation, and any adjustments are added for the total growth factors.

(4) The ARR is adjusted for inflation and facility aging factor for the new ARR.

(5) Total growth factors, new ARR, one-time requirements, and any program development incremental funding packages are added for total requirements.

(6) The direct funds applied are adjusted for migration, MILCON, and cost advantages for total resources.

(7) End of year BMAR is calculated as:

Total requirements - total resources

The construction engineering research lab provides the factors for facility aging and deterioration. The cost advantage is an adjustment for the state of the general economy. The model provides a methodology for predicting the future and has changed very little over the years. The primary disadvantage of the model is the human element. Humans are poor estimators of annual requirements and future funding levels, overestimate cost advantages, and divert funds from maintenance and repair to pay for utilities. [Ref. 33]

4. **Maintenance Resource Prediction Model**

In May 1982, the concept paper was developed for the Maintenance Resource Prediction Model (MRPM). The objective was to look at the policies and produce a model that would translate facilities into maintenance and repair requirements and determine when maintenance will happen. [Ref. 34] The purpose of the MRPM is to provide a tool to assist in the preparation of planning and programming resources based upon anticipated requirements of actual facilities. There are two types of MRPM systems -- personal computer system and Headquarters Integrated Facilities system (HQ-IFS). The personal computer system is designed for use by the installations, MACOMs, and the DA. The HQ-IFS is designed for use by the DA to perform predictions until the MACOMS and installations implement the personal computer system. [Ref. 35: p. 9] The Army is currently testing the personal computer system at ten sites [Ref. 34].

The MRPM main menu includes four functions: basic information, facility information, review and approval, and research. The basic information function contains data tables with general information about organizational charts, conversion tables, facility resource description data, and reference data for individual facilities.

The facility information function allows the user to define general information about each facility, model the construction components, perform resource prediction calculations, obtain reports, and ask questions about a facility or group of facilities. The review and approval function allows the user to calculate resource summary files by appropriation and DA management system code. The user will be able to produce the resource prediction information required by higher headquarters. The research function will allow the user to perform analyses of the installation resource data. [Ref. 35: pp. 12, 13]

The system is installation-designed and based on management by exception. For example, if the user programs into the system to have a facility's roof replaced in 1988, the model assumes the roof was replaced in that year unless the user tells it otherwise. The knowledge base is contained in the model. The model uses EPS for times to complete tasks, but each installation inputs its own shop rates. The installation inputs the general description of the facilities and quantities, for example, type of roof and square feet of roof surface. The model can make calculations at three different levels. The accuracy of the calculation depends on the detail provided. The minimum inputs required are the year built, use of facility, and size. The MRPM provides the optimal solution for determining maintenance and repair requirements in the future because it is based on life cycle, stores facility information in an automated mode, serves as an alert system for gearing visual inspection for future requirements, and identifies required ARR funding needed for BMAR not to increase. The primary disadvantage of the model is getting the basic information into the system. Many of the installations do not have the necessary information available about each facility, and inputting the information is very time intensive. Installations can submit and will receive funds without the MRPM. The model is a planning tool and management will have to be willing to change old habits. [Ref. 34]

5. **Army Management**

Effective management of maintenance and repair requires proper planning and programming of RPMA resources. The Army's general policy for maintenance and repair of facilities is that projects having an impact on the quality of life and unit readiness must be given highest priority. The following facilities are listed in priority sequence:

(1) Operational facilities

(2) Housing and dining facilities

(3) Critical utilities systems

(4) Medical facilities
(5) Maintenance shops
(6) Community facilities at remote sites
(7) All other

MACOM can approve variations from the general policy if overriding factors require a deviation. [Ref. 32: p. 1-1]

Installation reports are one method of evaluating RPMA management. Other methods used for evaluation are observations by Army Staff members on liaison visits to the sites and analysis of such factors as BMAR. HQDA uses the reporting data for the following: [Ref. 32: pp. 1-1, 3-1]

(1) Developing DA POM
(2) Developing RPMA budgets
(3) Managing the RPMA function
(4) Developing policies, standards, and programs
(5) Reporting to higher authorities such as DOD and Congress

6. **The Future**

The Army is currently revising AR 420-16. The new regulation will state that a requirement must be planned and scheduled on the annual work plan before it can become BMAR. [Ref. 33] Over the past several years, the Army has saved dollars through energy savings and other productivity initiatives. These savings have been reutilized for maintenance and repair of facilities. The future atmosphere of fiscal constraint and a weaker dollar abroad will restrict the Army's efforts toward further BMAR reduction while continuing facilities support. The Army plans to continue energy conservation and cost avoidance initiatives, improve installation master planning and space utilization, automate the engineer operations, encourage contractor competition, implement facility predictability models, and reduce maintenance and repair costs through innovative construction techniques, standard designs, and the use of modular and prefabricated facilities. [Ref. 30: pp. 2, 3]

V. DATA INTERPRETATION

A. DEFINITION AND GOALS

There is no uniform DOD definition of BMAR which is used across all services. Each service has its own working definition of BMAR. The Marine Corps' and Army's definitions are nearly the same. The Navy constrains BMAR to those items which are critical and cannot be deferred. The Air Force BMAR definition includes only projects-by-contract.

Service goals for BMAR range from no specific goal for the Air Force to reducing backlog to zero in the Navy. The Marine Corps' goal is to reach the containment level and the Army desires to keep BMAR at a "manageable level".

DOD does not realistically expect to reduce BMAR to the containment level. However, the increase in backlog does not mean the services are failing to take proper care of facilities. Commanders are reporting significant improvements in working and living conditions, which impact on morale, efficiency, and readiness. The BMAR is directly proportional to the management emphasis on backlog. Although DOD may not reach the containment goal established by Congress, the Congressional intent of containing further deterioration has been complied with. [Ref. 10: pp. 700, 701, 718, 750]

B. FACTORS WHICH CAUSE BMAR TO INCREASE

In spite of the additional funds provided by Congress for BMAR reduction, BMAR continues to increase. Several factors have been identified by the services as having influenced BMAR growth. These factors are discussed in the following sections.

1. Inflation

Inflation was identified by the services as contributing to the increase in BMAR [Ref. 1: p. 18]. Figure 5.1 provides a comparison of DOD's backlog in then-year dollars and constant 1986 dollars. It shows the overall real changes in backlog for fiscal years 1978-1986. If the containment level of $2,183 million were adjusted to constant 1986 dollars it would equal $3,600 million. Then DOD's backlog would have reached the containment level in fiscal year 1984. The DOD deflators applicable to maintenance and repair were used to convert then-year dollars into constant 1986

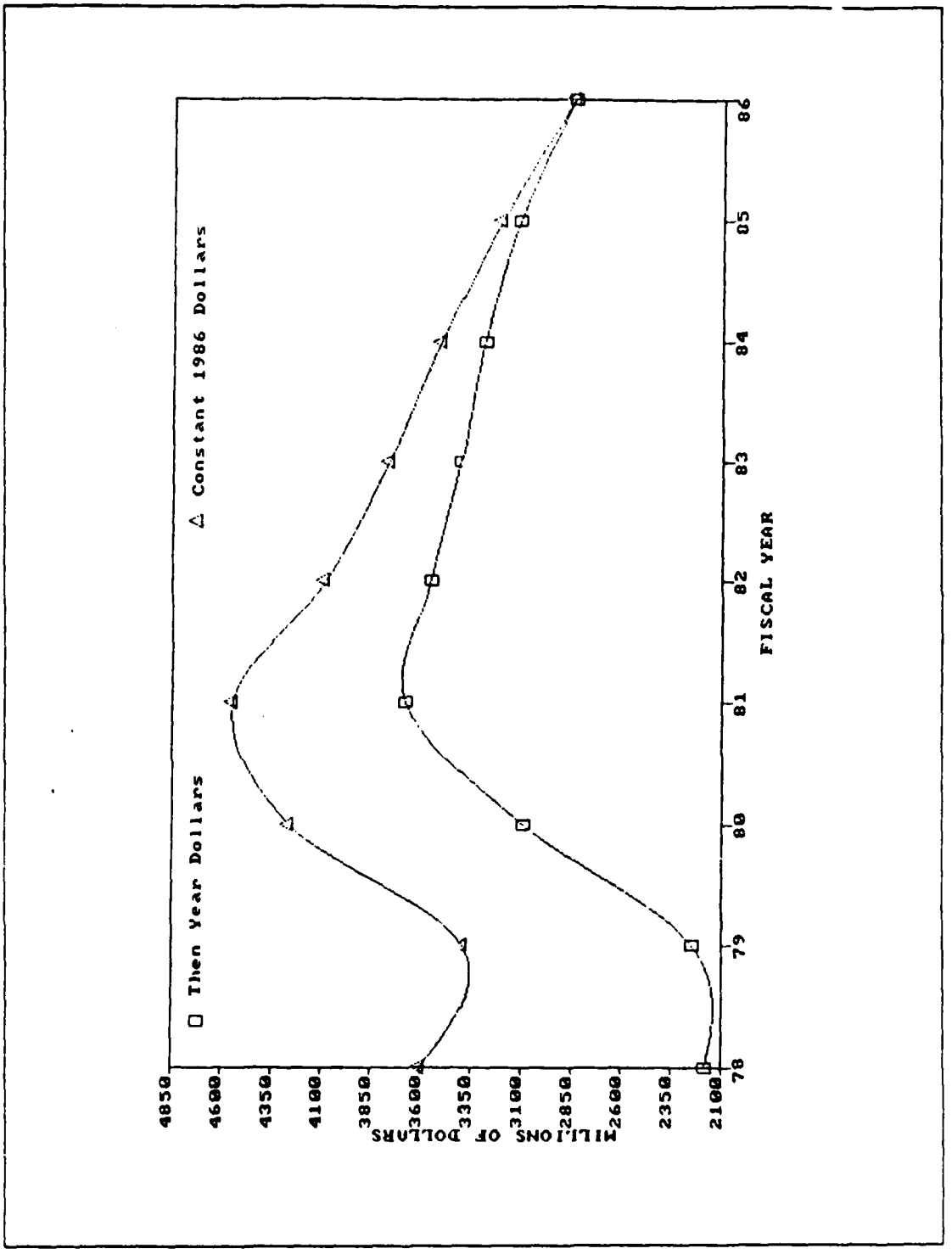

Figure 5.1 Comparison of DOD's Backlog in Then-Year Dollars and Constant 1986 Dollars.

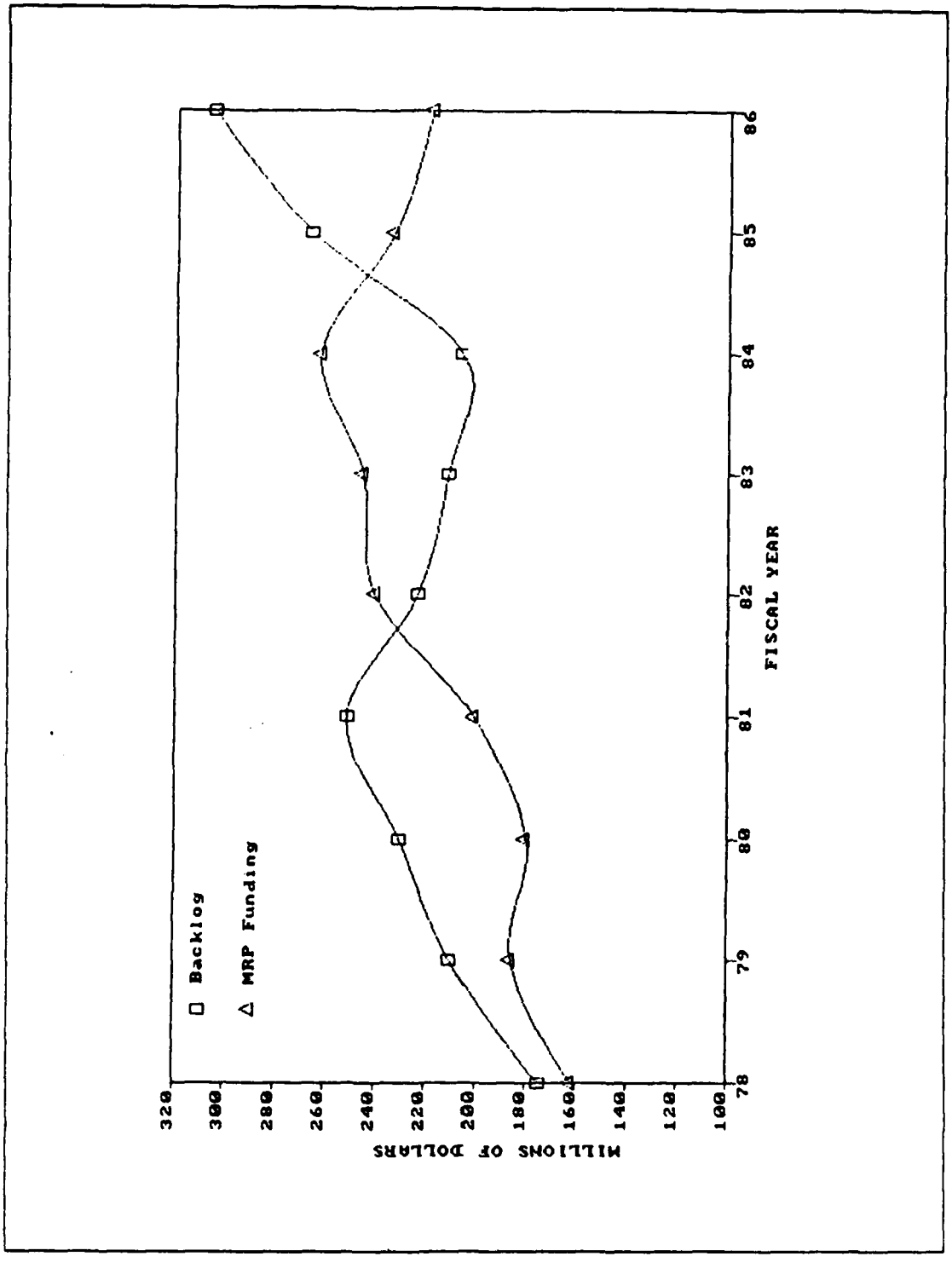

Figure 5.2 Comparison of Marine Corps MRP Funding and Backlog in Constant 1986 Dollars.

dollars. Figure 5.2 provides a comparison of the Marine Corps' actual MRP funding and backlog in constant 1986 dollars. Note that, as MRP funding increased during fiscal years 1981-1984, backlog decreased; and, when MRP funding began to decrease in fiscal year 1985, backlog increased.

2. **Increased Emphasis on Identifying Requirements**

Congressional criticism and the establishment of the containment level forced DOD to place more emphasis on identifying maintenance and repair requirements and BMAR. DOD shares the same concerns about increases in BMAR as Congress, whose concerns are identified in the following quote [Ref. 9: p. 33].

> The need for adequate maintenance of the DOD investment and identification of deficiencies have been aggressively emphasized over the past several years. The emphasis that is being applied has resulted in a program growth in the BMAR as accelerated in-house and contract actions have identified and validated outstanding deficiencies at a greater rate than resources for accomplishment became available.

As commanders place more emphasis on preserving facilities and providing better places for the people to work and live, facilities personnel work harder to identify and validate work to be done at the installations. Increased emphasis results in fewer inconsistencies and errors in reported data. [Ref. 10: pp. 700, 701]

The DON's Shore FLEP is an example of increased emphasis on critical maintenance and repair deficiencies. Shore FLEP has resulted in prioritized backlog reduction goals and significant changes in the use of O&MN funds for backlog reduction. Another example is the DA development of a life cycle model for determining future maintenance and repair requirements.

3. **Lower Priority of MRP Program**

A third reason for BMAR growth is the priority of competing programs [Refs. 1,33: p. 18]. Some unit commanders' concerns are focused on training and readiness and not maintenance of barracks. [Ref. 33] Commanders are given a mission and they exercise their own priorities in carrying out the mission. Keeping the flying hours and steaming hours at target levels has higher priority. Often there are requirements to absorb pay raises at the expense of the MRP program or to shift funds from maintenance to pay utilities bills. [Ref. 9: pp. 63, 70]

Congress established the MRP floor to make certain MRP funds were not diverted to other uses. However, the floor is based on the service's annual budget

request, which may not necessarily equate to the total funding needed to fully maintain real property. [Ref. 5: p. 19]

4. **Further Deterioration of Previously Identified Deficiencies**

A fourth reason for growth of BMAR is the continued deterioration of previously identified deficiencies which have not been corrected [Ref. 1: p. 18]. Maintenance and repair projects which are deferred for another fiscal year become more costly to repair. For example, a leaking gutter may start as several small holes in the gutter that could be mended. However, when the project is deferred, additional rusting occurs and eventually the entire gutter needs to be replaced. Deterioration is so highly regarded as a factor of BMAR that all the services calculate an adjustment for further deterioration in their BMAR model.

5. **Lack of Funding**

Another reason for BMAR growth is insufficient funding [Refs. 13,33: p. 53]. During the Vietman era, funding was not available for maintenance of facilities, especially at European sites [Ref. 33]. As discussed in Chapter II, MRP requirements increase due to increasing size of inventories, complexity, and age of facilities. MRP funding to the services has not kept pace with the increasing MRP requirements. To reduce BMAR, budget year funding must exceed the level of funding required to take care of current year maintenance and repair requirements. Figure 5.2 clearly shows what happens to BMAR when MRP funding is reduced.

6. **Human Nature**

Differences in human nature can also cause BMAR to grow [Refs. 13,36: p. 49]. BMAR projections involve the judgment of many individuals up the chain of command. At the installation level maintenance personnel, shop personnel, inspectors, planners, estimators, and engineers all get involved in identifying requirements. At a higher level, technicians, analysts, administrators, and engineers review the BMAR lists and may validate the BMAR. [Ref. 5: p. 52] The difference in an individual's knowledge, experience, and standards will affect their judgment and ability to identify requirements over time.

C. RELIABILITY OF BMAR

There is no standard approved method in DOD for determining annual maintenance and repair requirements or to translate requirements into a meaningful indicator of the condition of the facilities. The only standard indicator in use is BMAR. [Ref. 5: p. 57] The accuracy of the reported BMAR is highly questionable.

The findings of the 1981 GAO report discussed in Chapter II concluded that the service's reported BMAR cannot be relied on and was grossly understated [Ref. 11: p. 32]. Similarly, the House Surveys and Investigations Staff report in 1984 stated BMAR was a poor indicator for determining the condition of real property. In general, personnel had exceptionally low confidence that the BMAR list for their installation constituted the complete unfinanced maintenance and repair requirements. [Ref. 5: p. 55] Even the Deputy Assistant Secretary of Defense (Installations), Mr. Robert Stone, thought the backlog did not contain all the projects that have to be done at the installations [Ref. 10: p. 718].

D. ALTERNATIVES TO USING BMAR

1. Annual Recurring Requirement

One alternative to using BMAR as an indicator of maintenance and repair requirements is using an Annual Recurring Requirement (ARR). The ARR is an estimate of the current year's MRP total funding requirements. The ARR consists of the fixed costs of salaries and supplies for in-house work force, recurring contract maintenance costs, unforeseen emergencies, minor construction, and contract maintenance and repair projects. If the ARR is fully funded, BMAR will neither grow nor diminish. Any existing BMAR would have to be eliminated over a period of time. The ARR is a "cost of ownership" method of determining the amount of MRP funding needed to halt deterioration of real property. [Ref. 5: pp. 61, 62] The Army's efforts in developing a life cycle model for identifying total requirements follows this concept.

2. Percentage of Replacement Value

Another cost of ownership approach is to take a percentage of the replacement value of the real property and use that as the annual maintenance and repair funding needed to prevent further deterioration. A range within 1 to 3 percent of plant value would have to be established for each installation by investment category for use as the annual maintenance requirements. Engineers would have to use a weighting factor to identify a percentage based on the use of building, climate, age, etc. [Ref. 5: p. 62]

This approach would use a condition index as a relative indicator of deterioration. The condition index would be calculated as the difference between the annual cost of ownership funding requirement and the funding actually received for the fiscal year. The difference would represent the unfunded portion of the total requirement. Each year the cumulative difference is divided by the replacement value

and used as a percentage. Under this method, the condition index would get larger as the cumulative shortfall increases. A relatively high negative condition index would indicate a poor facility condition. A positive condition index would indicate excessive funding. [Ref. 5: pp. 62, 65]

The percentage of replacement value approach has the advantage of being used to project future possiblities and consequences. Based on the Military Construction Program, anticipated growth can be estimated. By estimating the various funding levels, each service could identify the impact of underfunding. The percentage of replacement value would be a simpler method of justifying MRP budgets and the condition index would be a more meaningful indicator of deterioration. [Ref. 5: pp. 62, 65] Additional advantages of this approach would be that a standard could be established for all services across similar facilities, manpower efforts would not be wasted on continually updating BMAR projects lists, and a readily identifiable relationship would exist between the plant property, the requirement, and the funding level [Ref. 10: p. 734]. The primary disadvantage of the percentage of replacement value approach is the difficulty in establishing factors to use in estimating maintenance requirements that are reliable enough to use across all services and installations, because each installation has different missions and priorities [Ref. 10: p. 735].

3. **Making BMAR More Useful**

The use of BMAR as a measurement of the condition of facilities is obviously inexact and perhaps should be used with other indicators. One of the best indicators of condition is personal observation. Commanders and senior level officials are reporting improvements in the appearance of real property at all installations. [Ref. 10: p. 701]

One method of making BMAR more useful is by improving the accuracy of BMAR reports submitted to each service headquarters. Commanders need to ensure all maintenance and repair work that has to be done is identified on annual work plans. Increased validation of BMAR lists is also required to improve accuracy. Another method of making BMAR more useful is to modify the BMAR goal. The BMAR containment levels should be revised to take into account the realistic factors of plant growth and inflation. BMAR can also be more useful by improving each service's ability to predict future BMAR levels. This can be done by continuing to refine the current BMAR models. [Ref. 37: pp. 4, 5]

E. COMPARISON OF SERVICE BMAR MODELS

Each of the service's BMAR models is used during the POM and budget cycles to predict future BMAR. The Navy, Marine Corps, and Air Force models calculate BMAR as a total entity, while the Army calculates BMAR separately for each of the major commands. The service models are similar in the following aspects:

(1) All the models take the current beginning BMAR figure from some type of report submitted up the chain of command from each installation.

(2) All the models adjust beginning BMAR for inflation and deterioration.

(3) MILCON is taken into account in all models.

(4) The Air Force and Army include migration of funds from other programs.

(5) The Marine Corps and Navy models use CPV.

(6) In all the models, ending BMAR becomes the beginning BMAR for the following year.

The service models differ in the following aspects:

(1) The Marine Corps model uses a non-linear curve to fit historical maintenance and repair funding and CPV to a curve. The resulting equation is then used to calculate future maintenance and repair funding requirements.

(2) The Army model makes an adjustment for cost advantages.

(3) The Navy model adjusts maintenance and repair funding for cost of ownership (overhead costs) and deferred funds.

(4) The Air Force model uses the 1984 amount as the baseline for maintenance and repair requirements.

The advantages and disadvantages of each of the models were discussed in the applicable sections of Chapters III and IV. However, the common advantage is ease of use. In this computer technology age, all the calculations are done by the computer and not by hand. Each service has found its own model to be fairly accurate in predicting future BMARs.

VI. FIELD QUESTIONNAIRE RESULTS

A. GENERAL

Up to this point, the thesis has focused on operations at the headquarters level and how the real property maintenance program is designed to operate at the individual field activities. No information was available on what was actually occuring at the working level. The field questionnaire was developed to fill this gap. It solicited information from the facilities maintenance officer at each field activity on actual operations in the areas of workload development, local prioritizing, planning and estimating, personnel, factors of BMAR, and reliability of BMAR. Most of the questions were subjective in nature. A copy of the questionnaire is included in Appendix B. The questionnaire was distributed to the Director of Facilities Management, or equivalent, at each of the nineteen major and four minor Marine Corps real property maintenance activities identified in Chapter III.

The initial field questionnaire was distributed on 20 August 1987 by HQMC (LFF-2) during the senior officers meeting at the Marine Corps Facilities Conference, Washington, DC. A follow-up letter was mailed to the real property maintenance activities on 22 September 1987. Of the twenty-three activities solicited, fifteen activities completed and returned the questionnaire; two of these were minor activities. One activity was unable to answer some of the questions because of its uniqueness. This activity has no in-house maintenance force and no LRMP. A Navy Public Works Center provides most of the maintenance support and all specific work, planning and estimating, annual inspections, and contract support.

The summary below does not make any statistical inferences because of the small population size. The statements identify only general patterns within the activities which responded.

B. SUMMARY

1. Relationship Between BMAR and MRP Funding

One might expect an inverse relationship between the amount of BMAR and the MRP funding provided to an activity over a period of time. However, only five of the fifteen activities experienced an inverse relationship during the five year period between fiscal years 1983-1987. Table 9 identifies the responses by activity.

TABLE 9

CHANGES IN BMAR AND MRP FUNDING

Activity	BMAR	MRP Funding
1	Increased Significantly	Increased Slightly
2	Increased Slightly	Increased Slightly
3	Increased Slightly	Increased Slightly
4	Increased Significantly	Decreased Slightly
5	Decreased Slightly	Increased Significantly
6	Increased Slightly	Decreased Slightly
7	Decreased Significantly	Increased Significantly
8	Stayed About the Same	Stayed About the Same
9	Increased Significantly	Increased Significantly
10	Increased Significantly	Decreased Slightly
11	Increased Slightly	Stayed About the Same
12	Increased Significantly	Increased Slightly
13	Increased Significantly	Increased Slightly
14	Increased Significantly	Increased Significantly
15	Increased Significantly	Increased Significantly

2. **Definition of Resource**

BMAR is the end-of-the-fiscal-year measurement of maintenance and repair work remaining as a firm requirement of the annual plan but which could not be accomplished in that fiscal year because of lack of resources. The questionnaire asked the activities to identify what "resources" included. Most of the activities interpreted "resource", as used in the definition of BMAR, to include dollars. Additionally, each activity included one to seven other items in its definition (see Table 10).

TABLE 10

RESOURCE INCLUDES

	Number of Activities
Dollars	13
Personnel to Perform in-House	13
Personnel to Prepare Specifications and Administer Contract	10
Lead Time Involved in Contracting Out Jobs	8
Material Support	8
New Work Identified During Year	6
Time to Complete Jobs	5

3. Factors of BMAR

The activities were asked to identify what factors cause BMAR to increase and to rank the factors as to their contribution to increasing BMAR. The major factors identified are better inspection procedures, increased age of real property, higher authority's increased emphasis on identifying backlog, and increasing inventory. A breakdown by each factor and the ranking of each is provided in Table 11.

TABLE 11
FACTORS CAUSING BMAR INCREASES

	Number of Activities	Ranking 1	2	3	4	5	6	7
Better Inspection Procedures	12	6	2	2	1	1		
Increased Age of Real Property	10	3	1	5	1			
Higher Authority's Increased Emphasis	9	2	1	2	1	1	1	1
Increasing Inventory	8	1	3	1		3		
Continued Deterioration	5		3		2			
Local Priority of MRP program	4	1		1		1	1	
Fiscal Constraints	4		1	1	1		1	
Increasing Contract Cost	3			1			2	
Real Inflation	2	1						1
Understaffing of Shops by T/O	1	1						
Variation in Human Ability	1		1					
Automation of Records	1		1					
More Aggressive Approach	1		1					
Limited Capabilities in Executing	1		1					

4. Prioritizing Requirements

The questionnaire requested the activities to identify what factors are considered in prioritizing M1 and R1 specific maintenance and repair requirements and to rank the factors as to their contribution in prioritizing. Most of the activities consider several factors in prioritizing maintenance and repair requirements. All of the activities use impact on mission and eleven of the activities ranked this item number one; the other four ranked this factor number two. Table 12 identifies the factors and the ranking of each.

5. Methods for Controlling BMAR

Table 13 summarizes the methods used by the activities to control BMAR. The main methods utilized are increasing contracting out and accomplishing the work.

TABLE 12

FACTORS IN PRIORITIZING M1 AND R1 REQUIREMENTS

	Number of Activities	Ranking 1	2	3	4	5	6	7
Impact on Mission	15	11	4					
Effect on Security	13		1	5	5	1		1
Effect on Energy Conservation	13			1	3	1	4	4
Rate of Further Deterioration	12	2	1	2	1	4	2	
Command Interest	12		3	4	1	1		3
Effect on Safety, Morale, & Welfare	11	1	5		1	4		
Potential for Future Increase Cost	10		1	3	2	1	3	
BMAR Funded First	1	1						

TABLE 13

METHODS USED TO CONTROL BMAR

	Number of Activities
Increase Contracting Out	13
Accomplish Work	12
Reevaluate the Requirement	7
Reprogram Requirement	6
Increase Reimbursable Work	1

6. **Engineered Performance Standards**

HQMC encourages field activities to use EPS to the maximum extent. Table 14 shows that most of the activities use EPS 71 to 90 percent of the time for estimating standing and specific jobs. The one activity which uses EPS 10 percent or less is a minor activity with only one building to maintain. When the activities use EPS, there is no general pattern in the results of comparing actual time to estimated time. Likewise, no pattern is apparent in comparing actual MRP costs to estimated costs. Table 15 shows the results.

TABLE 14

USE OF ENGINEERED PERFORMANCE STANDARDS

	Number of Activities
91-100% of the Time	3
81-90% of the Time	5
71-80% of the Time	6
61-70% of the Time	0
51-60% of the Time	0
41-50% of the Time	0
10% or less	1

TABLE 15

ACTUAL TIME AND COSTS TO ESTIMATED

	Number of Activities
Actual Time to Estimated	
Significantly Longer	1
Slightly Longer	3
About the Same	5
Slightly Shorter	4
Not Answered	2
Actual Costs to Estimated	
Significantly Higher	1
Slightly Higher	3
About the Same	7
Slightly Lower	4

7. **Comparison of Actual and Estimated Costs**

The activities were asked to identify the primary reason for differences between actual and estimated costs for jobs. Overall, the primary reasons for differences are changes in the scope of work, poor initial cost estimates, and differences in material costs. The total number of activities in Table 16 exceeds fifteen because three activities listed more than one item as the primary reason.

8. **Factors Considered for LRMP**

The questionnaire requested the activities to identify what factors are considered in annually updating the LRMP. As shown in Table 17, most of the

TABLE 16

PRIMARY REASON FOR DIFFERENCES

	Number of Activities
Changes in Scope of Work	6
Poor Initial Cost Estimates	3
Differences in Material Costs	3
Scheduling Problems	2
Innovative Methods and More Productive Work Force	2
Changes in Labor Rates	1
Journeymen Perform Better than Average Skilled Worker	1
Hidden Conditions	1
Work Force Competing with EPS	1

activities consider the annual inspection of facilities in updating the LRMP. Several activities consider other factors such as on-site surveys, facility history files, standing job orders, and material life expectancies.

TABLE 17

UPDATING LRMP

	Number of Activities
Annual Inspection of Facilities	14
On-Site Surveys	9
Facility History Files	8
Standing Job Orders	8
Material Life Expectancies	7
Emergency Orders	4
Master Plan & BMAR Program	1
Not Answered	1

9. **Personnel**

All of the activities indicated that the personnel who inspect, estimate, and administer the MRP program are properly trained. However, only nine activities indicated they had sufficient personnel to conduct controlled inspections; the other six did not have sufficient personnel.

10. **Local Model**

The questionnaire results indicated only three activities use a local model to help develop outyear maintenance and repair requirements. Each activity's model uses straight line projection.

11. **MRP Funding**

The activities varied in their response to what percent increase in MRP funding could effectively be handled by the activity for decreasing BMAR without reducing quality or impairing the mission. However, none of the activities indicated a percentage greater than 40 percent. Table 18 displays the results.

TABLE 18
INCREASE IN MRP FUNDING

	Number of Activities
10% Increase or Less	6
11-20% Increase	3
21-30% Increase	3
31-40% Increase	3

12. **Confidence in BMAR**

Respondents were asked to make subjective probability estimates of their confidence in the latest BMAR. The activities' confidence levels that all the projects listed on the latest BMAR are valid and accurately costed varied from a low of 66 percent to a high of 100 percent, with the majority in the 86-95 percent range, as shown in Table 19. Overall, the activities' confidence that the latest BMARs reflects the complete unfinanced maintenance and repair workloads at the activities appears to be lower. Table 20 shows that the range of confidence levels varies from a low of 56 percent to a high of 100 percent.

C. COMMENTS FROM FIELD ACTIVITIES

The questionnaire provided a space for the activities to comment on managing BMAR in the Marine Corps. One of the activities commented that BMAR should be minimal from year to year if financial support and the number of in-house personnel available for the maintenance and repair program are constant. A major drawback at

TABLE 19

CONFIDENT BMAR VALID & ACCURATE

	Number of Activities
96-100%	2
91-95%	6
86-90%	4
81-85%	0
76-80%	1
71-75%	1
66-70%	1

TABLE 20

CONFIDENT BMAR COMPLETE

	Number of Activities
96-100%	3
91-95%	2
86-90%	4
81-85%	1
76-80%	1
71-75%	2
66-70%	1
61-65%	0
56-60%	1

the small activities is the low contracting authority limit imposed by HQMC. Contracts greater than $10,000 have to be negotiated by the local Navy Public Works Officer. This further delays completion of the work. Another activity commented that, at overseas locations, true BMAR is not reflected in the dollar amounts reported because of the foreign currency conversion rate fluctuations.

A third activity indicated that BMAR growth in recent years is a factor of increased funding. Greater expectation of increased maintenance floors have encouraged facilities managers to identify and program for previously undocumented deficiencies.

A fourth activity commented that HQMC is willing to provide funds for BMAR reduction in a timely manner. However, the activity is restricted by the time and plethora of requirements needed to contract the projects. While the Engineering Field Division is responsive, time delays result while contracts are written and reviewed by various individuals. This activity indicated that each engineering field division should have a central contract specification library on disc to reduce time required for writing contracts.

A fifth activity stated that BMAR will never be reduced to zero at any given point in time because of the need to plan for maintenance and repair work in terms of future accomplishments. For example, a BMAR project may be scheduled to begin four months later to allow sufficient time for material acquisition or competitive contractual award. The LRMP is another example of planning and programming for the future. In recent years, this activity has experienced an 85 percent growth in square footage due to the MILCON program. Unfortunately this growth has not been matched by additional in-house maintenance billets or contract administration billets.

Another activity uses an automated long range maintenance plan in conjuction with its inspection program to identify requirements over a five year period. M1 BMAR is controlled by combining small projects into a single M2 project. The M2 projects are more cost effective because their size allows for greater competition during contracting. This activity has an ongoing five year project to stucco its building exteriors. When completed in fiscal year 1990, it will virtually eliminate the need for future exterior painting. This activity is able to utilize the local Navy Public Works Center in addition to its own in-house work force for accomplishing requirements. Projects are identified in the early stages of deterioration and local funds are provided for A&E design. Then, when BMAR funds become available, the projects are ready to contract. The ongoing MILCON program is expected to increase building space by 30 percent by fiscal year 1990. Without additional funding, it will not be possible to maintain the current level of facilities standards.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Overall, the Marine Corps' MRP program is well designed and, if consistently complied with, should result in effective management of real property. The MRP program is based on established DOD maintenance standards and Navy general maintenance inspection standards. The annual controlled inspection program is the foundation for developing the maintenance and repair workload for an activity. Each activity develops an unconstrained LRMP which is updated annually. In addition to annual inspections, Marine Corps activities consider on-site surveys, material life expectancies, standing job orders, facility history files and emergency orders in updating the LRMP. The first year of the LRMP becomes the annual work program.

The use of EPS in the Marine Corps is encouraged to increase the accuracy of estimates and aid in planning and scheduling tasks. In general, field activities use EPS for estimating standing and specific jobs more than 70 percent of the time. However, from the data obtained in this study, no conclusions can be drawn about the effectiveness of EPS.

The Marine Corps has the most comprehensive validation of BMAR deficiencies of all the services. Staff representatives from CMC conduct annual on-site validation of all BMAR major repair work and demolition items for each Marine Corps RPMA. Each BMAR project is prioritized based on the numerical score received during the validation.

Over the years, the reliability and accuracy of the reported BMAR has been challenged. The reliability and accuracy of the Marine Corps' BMAR improves every year. Two years ago the old BMAR model used by HQMC to predict outyear BMAR for budgets was significantly changed. The current model is still crude, but HQMC is actively investigating additional refinements to the current BMAR model to further improve its accuracy. In addition, increased emphasis by HQMC and activity commanders for identifying all deficiencies, better inspection procedures, and improved reporting procedures continue to improve the accuracy of BMAR each year. However, BMAR is not 100 percent reliable and will not be so until technological methods are available for complete detection of problems with underground utility distribution systems, hidden structural damage, etc.

Many factors influence the growth of BMAR. Some of these factors, like inflation and increasing age of facilities, cannot be controlled by the services. Other factors, such as priority of the MRP program, insufficient funding, increasing inventory, further deterioration of previously identified deficiencies, inspection procedures, and variations in human ability can, to certain degrees, be controlled by the services.

Currently Congress uses BMAR as the key indicator of the condition of real property in DOD. However, it is not a true indicator. Since fiscal year 1978, total DOD BMAR has increased, but that does not necessarily mean the condition of real property has deteriorated. In fact, all the services have reported improvements in the living and working areas and overall appearance of real property at all installations. Alternatives to using BMAR as a sole indicator of real property condition should be explored.

It is highly unlikely during the current period of austere funding that the Marine Corps will be able to reach the BMAR containment goal in the near future without a change in operations. MRP funding has not kept pace with the increasing MRP requirements at the activities. Increases in real property square footage due to MILCON and JFIP projects have not resulted in sufficient additional MRP funding nor additional manpower billets to conduct inspections, provide in-house maintenance, or develop and administer contracts.

B. RECOMMENDATIONS

The following recommendations are proposed for consideration by HQMC.

1) When MILCON, JFIP, and nonappropriated fund projects are identified and reviewed, ensure appropriate RPMA funding packages are included. Funding should be identified to support maintenance and repair of the facility, utilities operations, and other engineering support necessary to operate and maintain the facility. In addition, manpower requirements should be evaluated to ensure the activity has sufficient inspectors, planners, estimators, engineers, in-house maintenance personnel, contract administrators, etc. to support the additional real property.

2) If the Marine Corps seriously wants to reduce BMAR to the containment level in the near future, it will have to make some significant change, such as developing and implementing a program similar to the NAVY's Shore FLEP. First, CMC needs to make a financial commitment to the MRP program and fully fund annual maintenance and repair requirements for each activity to stabilize BMAR growth. Second, HQMC needs to provide activities with sufficient manpower billets to handle inspections, in-house maintenance,

contracting, and other support requirements. Third, HQMC needs to design a program to eliminate the current BMAR and provide field activities with additional funds for BMAR reduction. In conjuction, field activities should be allowed to hire additional personnel to support the increased contracting workload that will accompany the increased funds. HQMC also needs to emphasize to the field commanders the importance of maintaining real property, improving inspection procedures, retaining high quality personnel, and taking intermediate steps to decelerate further deterioration of identified deficiencies when possible.

3) Investigate the use of Annual Recurring Requirements as an alternative or in addition to BMAR. The ARR should cover the fixed costs of in-house workforce and supplies, continual contract maintenance projects, minor construction, emergencies, and specific contract maintenance and repair projects. Identification of ARR in the budget should make Congress aware of the total annual maintenance and repair requirements. Then, if funding is provided at a lower level, Congress should expect growth in BMAR. A fully developed model, such as the Army's life cycle model, could become an indispensable management tool at the field activity level for identifying annual recurring requirements.

4) Investigate the development of a personal computer data base management system for field activities, similar to the Army's Maintenance Resource Prediction Model which is based on life cycle costs. Having this capability would allow individual activities not only to calculate resource requirements for budget submissions but also to perform local facility analysis, improve planning and scheduling of projects, prepare LRMP and annual work program, generate specialized and general reports, and provide a computerized history file on each facility.

In most instances, implementing the above recommendations will require additional dollars. Realistically, it may not be possible for the Marine Corps to obtain an increase in the operations and maintenance appropriation from Congress to support hiring additional personnel, fully funding annual maintenance and repair requirements, BMAR reductions, or developing a computer management system for the field activities. Instead, the Marine Corps may have to make trade-offs by sacrificing other programs for the needed increases in the MRP program.

APPENDIX A
GLOSSARY OF ACRONYMS

A&E	Architectural and Engineering
AIS	Annual Inspection Summary
ARR	Annual Recurring Requirement
ASN	Assistant Secretary of the Navy
BMAR	Backlog of Maintenance and Repair
BY	Budget Year
CECORS	Civil Engineering Contract Reporting System
CMC	Commandant of the Marine Corps
CMDR	Activity Commander
CNO	Chief of Naval Operations
CPV	Current Plant Value
DA	Department of the Army
DOD	Department of Defense
DON	Department of the Navy
EPS	Engineered Performance Standards
FCC	Functional Category Code
FY	Fiscal Year
GAO	General Accounting Office
HQ-IFS	Headquarters Integrated Facilities System
HQMC	Heaquarters, Marine Corps
HQ USAF	Headquarters, United States Air Force
HQDA	Headquarters, Department of the Army
IC	Investment Category
JFIP	Japanese Facilities Improvement Program
LRMP	Long Range Maintenance Plan
MACOM	Major Command (Army)
MAJCOM	Major Command (Air Force)
MCO	Marine Corps Order
MILCON	Military Construction
MPMC	Military Personnel, Marine Corps
MRP	Maintenance of Real Property

MRPM	Maintenance Resource Prediction Model
MRRP	Maintenance and Repair of Real Property
MWR	Morale, Welfare, and Recreation
NAVCOMPT	Navy Comptroller
NAVFACENGCOM	Naval Facilities Engineering Command
NFADB	Navy Facility Assets Data Base
O&MMC	Operations and Maintenance, Marine Corps
O&MN	Operations and Maintenance, Navy
OSD	Office of the Secretary of Defense
OSHA	Occupational Safety and Health Act
POM	Program Objective Memorandum
PPBS	Planning, Programming, and Budgeting System
RAC	Risk Assessment Code
RPMA	Real Property Maintenance Activities
Shore FLEP	Shore Facility Life Extension Program
URR	Unconstrained Requirements Report

APPENDIX B
FIELD QUESTIONNAIRE

Q-1 Which of the following best describes your activity's total backlog of maintenance and repair (BMAR) over the past five years (FY83-87) in real dollar terms? (Circle number of your answer) DON average inflation rate for the past five years is 2.9%.

1 INCREASED SIGNIFICANTLY
2 INCREASED SLIGHTLY
3 STAYED ABOUT THE SAME
4 DECREASED SLIGHTLY
5 DECREASED SIGNIFICANTLY

Q-2 Which of the following best describes your activity's total maintenance of real property (MRP) funding over the past five years (FY83-87) in real dollar terms? (Circle number) DON average inflation rate for the past five years is 2.9%.

1 INCREASED SIGNIFICANTLY
2 INCREASED SLIGHTLY
3 STAYED ABOUT THE SAME
4 DECREASED SLIGHTLY
5 DECREASED SIGNIFICANTLY

Q-3 BMAR is defined as the end-of-fiscal-year measurement of maintenance and repair work remaining as a firm requirement of the annual plan but which could not be accomplished in that fiscal year because of lack of resources. Which of the following items does your activity interpret "resource" to include? (Circle all applicable numbers)

1 DOLLARS
2 LEAD TIME INVOLVED IN CONTRACTING OUT JOBS
3 TIME TO COMPLETE JOBS
4 PERSONNEL TO PREPARE SPECIFICATIONS AND ADMINISTER CONTRACT
5 PERSONNEL TO PERFORM IN HOUSE
6 MATERIAL SUPPORT
7 NEW WORK IDENTIFIED DURING YEAR WHICH BECAME PART OF THE ANNUAL PLAN
8 OTHER (please specify)

_____
_____
_____

Q-4 What factors cause BMAR to increase at your activity? (Circle all applicable numbers)

1 REAL INFLATION GREATER THAN DOD ALLOWANCE
2 HIGHER AUTHORITY'S INCREASED EMPHASIS ON IDENTIFYING BACKLOG
3 INCREASED AGE OF REAL PROPERTY
4 VARIATION IN HUMAN ABILITY TO IDENTIFY REQUIREMENTS
5 BETTER INSPECTION PROCEDURES
6 INCREASING INVENTORY
7 FISCAL CONSTRAINTS
8 CONTINUED DETERIORATION OF PREVIOUSLY IDENTIFIED DEFICIENCIES NOT CORRECTED
9 LOCAL PRIORITY OF MRP PROGRAM IN RELATIONSHIP TO OTHER PROGRAMS AT ACTIVITY
10 INCREASING CONTRACT COST
11 OTHER (please specify)

_____
_____
_____

Q-5 Please rank the factors identified in the previous question as to their contribution to increasing BMAR. (Use 1 for the item that contributes the most to BMAR, use 2 for the next factor, etc. Leave blank for all factors not previously circled in Q-4)

__ REAL INFLATION GREATER THAN DOD ALLOWANCE
__ HIGHER AUTHORITY'S INCREASED EMPHASIS ON IDENTIFYING BACKLOG
__ INCREASED AGE OF REAL PROPERTY
__ VARIATION IN HUMAN ABILITY TO IDENTIFY REQUIREMENTS
__ BETTER INSPECTION PROCEDURES
__ INCREASING INVENTORY
__ FISCAL CONSTRAINTS
__ CONTINUED DETERIORATION OF PREVIOUSLY IDENTIFIED DEFICIENCIES NOT CORRECTED
__ LOCAL PRIORITY OF MRP PROGRAM IN RELATIONSHIP TO OTHER PROGRAMS AT ACTIVITY
__ INCREASING CONTRACT COST
OTHER (please specify)

__ _____
__ _____
__ _____

Q-6 What methods does your activity use to control BMAR? (Circle all applicable numbers)

1 ACCOMPLISH WORK AND THUS ELIMINATE REQUIREMENT
2 REEVALUATE THE REQUIREMENT
3 REPROGRAM REQUIREMENT INTO FOLLOWING FISCAL YEAR
4 INCREASE REIMBURSABLE WORK
5 INCREASE CONTRACTING OUT
6 OTHER (please specify)

_____
_____
_____

Q-7 What factors does your activity consider in prioritizing MI and RI specific maintenance and repair requirements? (Circle all applicable numbers)

1 COMMAND INTEREST
2 IMPACT ON MISSION
3 POTENTIAL FOR FUTURE INCREASED MAINTENANCE COST
4 EFFECT ON SAFETY, MORALE, AND WELFARE OF PERSONNEL
5 EFFECT ON SECURITY
6 EFFECT ON ENERGY CONSERVATION
7 RATE OF FURTHER DETERIORATION
8 OTHER (please specify)

_____
_____
_____

Q-8 Please rank the factors identified in above question as to their contribution in prioritizing. (Use 1 for the item that is most important, use 2 for the next factor, etc. Leave blank for all factors not previously circled in Q-7)

_ COMMAND INTEREST
_ IMPACT ON MISSION
_ POTENTIAL FOR FUTURE INCREASED MAINTENANCE COST
_ EFFECT ON SAFETY, MORALE, OR WELFARE OF PERSONNEL
_ EFFECT ON SECURITY
_ EFFECT ON ENERGY CONSERVATION
_ RATE OF FURTHER DETERIORATION
_ OTHER (please specify)

_ _____
_ _____
_ _____

Q-9 How often does your activity use engineered performance standard (EPS) in estimating standing and specific jobs? (Circle number)

1 91-100% OF THE TIME
2 81-90% OF THE TIME
3 71-80% OF THE TIME
4 61-70% OF THE TIME
5 51-60% OF THE TIME
6 41-50% OF THE TIME
7 31-40% OF THE TIME
8 21-30% OF THE TIME
9 11-20% OF THE TIME
10 LESS THAN 10% OF THE TIME

Q-10 Overall, when the EPS are used, how well does actual time differ from estimated time? (Circle number)

1 SIGNIFICANTLY LONGER
2 SLIGHTLY LONGER
3 ABOUT THE SAME
4 SLIGHTLY SHORTER
5 SIGNIFICANTLY SHORTER

Q-11 Overall, how does actual MRP costs for jobs differ from estimated costs? (Circle number)

1 SIGNIFICANTLY HIGHER
2 SLIGHTLY HIGHER
3 ABOUT THE SAME
4 SLIGHTLY LOWER
5 SIGNIFICANTLY LOWER

Q-12 What is the primary reason for differences between actual and estimated costs for jobs? (Circle number)

1 CHANGES IN SCOPE OF WORK
2 DIFFERENCES IN MATERIAL COSTS
3 POOR INITIAL COST ESTIMATES
4 SCHEDULING PROBLEMS
5 CHANGES IN LABOR RATES
6 OTHER (please specify)

_____

_____

Q-13 What factors does your activity consider in annually updating the long range maintenance plan (LRMP)? (Circle all applicable)

1 ANNUAL INSPECTION OF FACILITIES
2 STANDING JOB ORDERS
3 FACILITY HISTORY FILES
4 ON-SITE SURVEYS
5 EMERGENCY ORDERS
6 MATERIAL LIFE EXPECTANCIES
7 OTHER (please specify)

_____
_____
_____

Q-14 Does your activity use a local model to develop outyear maintenance and repair requirements? (Circle number)

1 YES
2 NO

If yes, please identify what the model is used for. _____

_____

_____

Q-15 What type of methodology does your local model use? (Circle number)

1 STRAIGHT LINE PROJECTIONS
2 PHYSICAL INVENTORIES
3 LIFE CYCLE COST
4 FORMULA FUNDING
5 OTHER (please specify)

_____

Q-16 Does your activity have sufficient personnel to conduct controlled inspections? (Circle number)

1 YES
2 NO

Q-17 Are the personnel who inspect, estimate, and administer the MRP program properly trained? (Circle number)

1 YES
2 NO

Q-18 Given the same number of personnel, what percent increase in MRP funding could your activity effectively handle to decrease BMAR without reducing quality or impairing the mission? (Circle number)

1 10% OR LESS
2 11-20%
3 21-30%
4 31-40%
5 41-50%
6 51% AND GREATER

Q-19 How confident are you that all the projects listed on the latest BMAR are valid and accurately costed? (Circle number)

1 96-100%
2 91-95%
3 86-90%
4 81-85%
5 76-80%
6 71-75%
7 66-70%
8 61-65%
9 56-60%
10 51-55%
11 LESS THAN 50%

Q-20 How confident are you that the latest BMAR reflects the complete unfinanced
maintenance and repair workload at your activity? (Circle number)

1 96-100%
2 91-95%
3 86-90%
4 81-85%
5 76-80%
6 71-75%
7 66-70%
8 61-65%
9 56-60%
10 51-55%
11 LESS THAN 50%

Please use this space to provide any comments you may have on managing BMAR in the Marine Corps.

APPENDIX C
SERVICE INTERVIEW QUESTIONS

1. What specific directive regulations are relevant?
2. Do you have an established service BMAR goal?
3. What is your service definition of BMAR?
4. What procedures does each individual activity use to identify maintenance and repair requirements?
5. When and in what form are requirements submitted to your office?
6. What procedures does your office use for consolidating requirements for budget submissions?
7. Do you use any type of model? If so, what is the model used for?
8. How does the model work? What methodology?
9. How long have you been using the model?
10. What are the advantages and disadvantages of the model?
11. How are MRP BMAR requirements validated?
12. What would you say are the determinants of BMAR?
13. How successful has your service been in predicting maintenance and repair requirements?
14. What are your future plans in the area of MRP and BMAR identification?

APPENDIX D
HQMC PROJECT SURVEY DATA SHEETS

[illegible] PROJECT SURVEY DATA SHEET

MAJOR REPAIR

ACTIVITY NAME (PROJECT) COMMAND PRI (1 of tot) of

PROJECT # TITLE COST

PROJECT [illegible] CAT CODE COST BENEFIT RATING

A. Associated with construction proj? Y/N Proj no. _____

COMMAND PRIORITY

LEVEL 1	MID 1	1	2	MID 2	3
15	13	10	6	2	0

FACILITY USE

	LOW		MED	HIGH
OPERATIONS	17	18	19	20
TRAINING	14	15	16	17
MAINTENANCE/BOS	12	13	14	15
UTILITIES	11	12	13	14
EXPENDABLES/RESPALLS	10	11	12	13
ST PARK	5	6	7	8
AWR	4	5	6	7
OTHER	1	5	10	20

	NO			YES
[illegible] COST IN FUTURE FACTOR				
A. [illegible] will escalate considerably if delayed one year?	0	5	8	10
B. Is project self amortizing?	0	5	8	10
C. Will delaying project cause deterioration of other assets?	0	5	8	10
IMPACT ON MISSION IF DELAYED [illegible]	0	5	10	15
PROJECT GENERATED TO MEET [illegible] FIRE CODE [illegible]	0	2	7	10

HQMC REP. _____ ACT REP: _____ TOTAL: _____

REMARKS: _____

HQMC O&M PROJECT SURVEY DATA SHEET

MINOR CONSTRUCTION

ACTIVITY NAME _____ / / YR/MO/DAY _____ COMMAND PRI (1 of tot) _____ of _____

PROJECT NO. _____ TITLE _____ COST _____

FACILITY NO./USE _____ CAT CODE _____ COST BENEFIT RATING _____

A. Has site approval been obtained? (ref para 3003 of MCO P11000.12) Y/N

B. Associated with repair proj? Y/N Proj no. _____

COMMAND PRIORITY

UPPER 1/3	MID 1/3	LOWER 1/3
25-22	18-12	10-5

OPERATIONAL INFLUENCE

DIRECT		INDIRECT		NONE
20	15	10	5	0

FACILITY USE

	LOW	MID	HIGH
OPERATIONS	16	18	20
TRAINING	14	16	18
MAINTENANCE	12	14	16
UTILITIES	10	12	14
HABITIBILITY/MESSHALLS	8	10	12
STORAGE	4	6	8
MGR	2	4	6
OTHER	1	7	14

REQUIREMENT IS:

CMC DIRECTED PROG	10
CHANGE IN MISSION	5
SELF AMORTIZING (W/I 5 YRS)	5
CONCURRENT W/M2	15

HQMC REP: _____ ACT REP: _____ TOTAL: _____

REMARKS: _____

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